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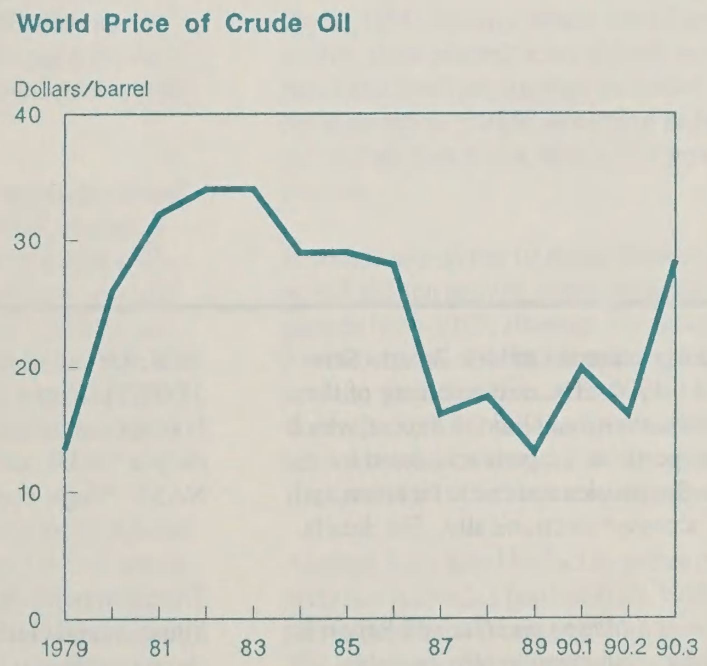

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Summary

The U.S. agricultural sector's energy supply and price expectations reflect perceptions of world crude oil market conditions. Though world crude oil supplies are currently judged to be adequate, prices are higher as a result of uncertainty surrounding the Middle East crisis. If the world price of crude oil averages $30 per barrel next year, compared with the earlier projection of $20.90, then farm energy expenses for diesel fuel, gasoline, liquified petroleum gas, and electricity will rise by 10 to 15 percent. A crude oil average price of $40 per barrel would increase farm energy expenses around one-fourth.

In 1990, farm energy expenses will increase slightly, to $7.2 billion. This represents a modest gain in total cropland planted and harvested and a slight increase in the number of acres irrigated, coupled with higher refined petroleum product prices in the later part of the year. Farm energy expenditures are expected to account for 6.2 percent of total cash production expenses. A further increase in farm energy expenditures is likely for 1991. The increase in the motor fuels tax (applicable to both diesel fuel and gasoline), as a result of the Budget Reconciliation Act (H.R. 5835), will increase farm energy expenditures by 1.5 percent.

Expenditures for tractors and other farm machinery rose $1.5 billion in 1989. The rise continued in 1990, but not as rapidly as from 1988 to 1989. Farm debt continued to decrease in 1989 and asset values continued to rise, for both real estate and nonreal estate. However, direct government payments dropped 25 percent from 1988 to 1989. Sales of farm machinery for the first seven months of 1990 were up slightly from the same period a year ago, but sales for August were down for most categories of farm machinery compared to August 1989.

Sales of tractors in the higher horsepower ranges continued to rise. The sales forecast for four-wheel-drive tractors is down from the February forecast, but still represents a 32-percent gain from 1989. The 1990 forecast of the value of farm machinery and equipment exports is $2.7 billion, according to the Department of Commerce. With imports forecast at $2.6 billion, 1990 will be the second year since 1985 that the value of farm machinery and equipment exports exceed the value of imports.

Conventional tillage methods were used on over 80 percent of the 1990 winter wheat acreage in 12 major winter wheat producing States; 12 percent with the moldboard plow and 69 percent without. Nearly 40 percent of the 1989 fall potato acreage was conventionally tilled with a moldboard plow and 54 percent without.

Fields designated as highly erodible were used for 29 percent of the winter wheat acreage and 21 percent of the fall potatoes in the survey States.

For the 1989/90 crop year, preliminary data indicate that seed use for the eight major crops declined to 6.3 million tons from 6.5 million tons the previous year, due to slightly lower planted acreage. Most field seed prices, in 1990, fell from the 1989 level, as supplies exceeded demand. Forage seed prices were also generally lower this year, compared to the previous year, as demand declined due to a decrease in the growth of the Conservation Reserve Program acreage. The prices paid index for seeds fell 4.1 percent in 1990, following a 13-percent increase in 1989. Farm seed expenditures in 1990 are expected to fall due to lower seed prices.

In 1989 the U.S. net trade surplus in seeds for planting surged 24 percent to $342 million. This increase primarily reflected gains in soybean, grain sorghum, flower, and forage seed exports. Gains in exports were partly offset by respective declines of 8 percent and 50 percent in vegetable and sugarbeet seed exports.

U.S. fertilizer supplies in 1991 should be adequate for anticipated use, but at higher prices which might result in reduced fertilizer application rates on 1991 crops. U.S. plant nutrient use in 1989/90 is estimated at 20.1 million tons, up 3.5 percent from the previous year, due to additional corn and wheat plantings.

Spring 1990 fertilizer prices were 7 percent less than a year earlier, since planted acres did not increase as much as anticipated and fertilizer supplies exceeded demand. Wholesale fertilizer prices started increasing in July, and as a result of the Middle East crisis, they might go up an additional 4 to 7 percent.

Pesticide use on the 10 major field crops in 1990 is projected at 465 million pounds active ingredient (a.i.), up 1.5 million pounds from 1989, although the area planted declined about 3 million acres. Herbicide use declined 1 million pounds a.i. because the 2.9 million acre drop in soybean acreage more than offset the 2.2 million acre increase in corn acreage. Insecticide use increased 2.5 million pounds a.i. largely on the strength of a 1.7 million acre increase in cotton acreage.

Average farm-level herbicide prices rose 4.7 percent and insecticide prices 2.2 percent from 1989 to 1990. Pesticide prices have been increasing 3 to 5 percent in recent years. The jump in world oil prices may add an additional 1 to 3 percent to manufacturing costs.

Energy

The turmoil in the world crude oil market caused by the Middle East crisis has led to considerable uncertainty regarding the prices farmers will pay for refined petroleum products in the future. The pre-embargo (i.e., the United Nations' sanctioned trade embargo of Iraq) estimate of the world price of crude oil for 1991 was $20.90 per barrel. Currently, the world price is more than 50 percent higher than this estimate and will rise further if the Middle East situation continues to deteriorate.

If the world price of crude oil remains at about $30 per barrel, then farm energy expenses for diesel fuel, gasoline, liquified petroleum gas, and electricity will rise by approximately 13 percent over energy costs had the $20.90-per-barrel price been maintained. A rise in the price of crude oil to an average of $40 per barrel would increase farm energy expenses 25 percent.

Note that, since approximately 6 percent of the electricity generated in the United States uses refined petroleum products as the boiler fuel, an increase in the price of crude oil results in higher generating costs and hence a higher price for electricity to end-use consumers.

The World Crude Oil Price

During the first half of 1990, the world crude oil price declined from a post-1985 high of more than $20 per barrel to $13 per barrel, a drop of 35 percent. The crude oil price, which had been buoyed by the unusually cold winter, fell significantly in the early months of the year as the weather turned mild and production from the Organization of Petroleum Exporting Countries (OPEC) remained high. Moreover, the U.S. economy was experiencing a slowdown in growth resulting in declining demand and a sizable buildup of crude oil stocks.

Between June and late July of this year, oil prices had begun to recover as OPEC agreed to enforce production quotas more aggressively. The Iraqi invasion of Kuwait on August 2, 1990, resulted in further immediate and large price hikes as trade sanctions against Iraq were introduced. The immediate impact has been an increase in the spot market world crude oil price to around $35 to $40 per barrel and a loss of combined Iraqi and Kuwaiti production of 4.3 million barrels per day. (All but about 1 million barrels per day of this loss is expected to be made up by other producing nations by November 1990.) Because of the current instability of crude oil markets, a definitive assessment of the future course of the price of crude oil is not possible.

Petroleum Consumption and Production

The Department of Energy (DOE) has produced an analysis of the consumption and production of refined petroleum

Table 1--U.S. petroleum consumption-supply balance

Item	1987	1988	1989	Forecast 1990	Forecast 1991
	Million barrels/day				
Consumption:					
Motor gasoline	7.21	7.34	7.33	7.29	7.14
Distillate fuel	2.98	3.12	3.16	3.04	3.01
Residual fuel	1.26	1.38	1.37	1.26	0.97
Other petroleum 1/	5.22	5.45	5.47	5.52	5.43
Total	16.67	17.29	17.33	17.11	16.56
Supply:					
Production 2/	10.65	10.51	9.91	9.57	9.60
Net crude oil and petroleum imports (includes SPR) 3/	5.91	6.59	7.20	7.55	6.87
Net stock withdrawals	0.04	0.19	0.21	-0.01	0.10
Total	16.60	17.29	17.32	17.11	16.57
	Percent				
Net imports as a share of total supply	35.60	38.11	41.57	44.13	41.46
	% change from previous year				
Consumption		3.72	0.23	-1.27	-3.21
Domestic Production		-1.31	-5.71	-3.43	0.31
Imports		11.51	9.26	4.86	-9.01

1/ Includes crude oil product supplied, natural gas liquid (NGL), other hydrocarbons and alcohol, and jet fuel.
2/ Includes domestic oil production, NGL, and other domestic processing gains (i.e., volumetric gain in refinery cracking and distillation process).
3/ Includes both crude oil and refined products. SPR denotes the Strategic Petroleum Reserves.

Source: U.S. Department of Energy, Energy Information Administration. Short-Term Energy Outlook. DOE/EIA-0202(90/3Q). September 1990.

products, assuming an average world price of crude oil of $30 per barrel is realized through 1991 (table 1). With a higher world crude oil price and a sluggish economy, petroleum demand is expected to decline. At a world oil price of $30 per barrel, the demand for all refined petroleum products in 1991 is expected to be 16.6 million barrels per day, a 3.2 percent decline from the previously projected 1991 level, which assumed a world price of crude oil of $17.50 per barrel.

On the supply side, a world oil price of $30 per barrel is expected to slow, but not reverse, the rate of decline in domestic crude oil production in 1990 and 1991. Growth in crude oil imports is expected to reverse from an increase of 6.3 percent for 1990 to a 5.9 percent decline for 1991, largely as a result of reduced consumption. In 1991, total net petroleum imports are projected to decline for the first time since 1985. If the average world price of crude oil rises above $30 per barrel, domestic production might even post an increase in 1991. This is based on the assumption that the oil industry perceives that the higher price of crude oil will be permanent enough to justify significant investment in drilling and development.

In the $30-per-barrel-world-oil case, the price of crude oil is assumed to increase by nearly $14 per barrel (33 cents per gallon) from the second quarter to the fourth quarter of 1990. Most refined petroleum product prices would increase by about 35 cents per gallon during this period, indicating that

the refiner margin would change little from second quarter levels. Crude oil prices are assumed to remain at $30 per barrel throughout 1991. The average price of crude oil for 1991 is assumed to be $9 per barrel or 21 cents per gallon higher than the 1990 average. It is anticipated that most of this price increase would be reflected in the price of diesel fuel, gasoline, and liquified petroleum gas. Unrelated to events in the Persian Gulf, retail motor gasoline prices are expected to be 2 cents per gallon higher than a year ago, as State and local excise tax increases enacted in mid- to late-1990 take effect fully and as general inflation raises production costs.

In the $30-oil-price case, the consumption of most refined petroleum products is expected to decline in 1990 and 1991. In the transportation sector, slow economic growth and higher prices for gasoline and diesel fuel are expected to dampen travel demand. Growth in motor vehicle-miles traveled is expected to be more than offset by the continued improvements in vehicle efficiency that yield declining use of gasoline and diesel fuel. Higher fuel costs are expected to result in higher airline ticket prices, which in turn should keep commercial jet fuel demand weak in 1990 and 1991. Total jet fuel demand will probably increase in 1990 because of a surge in military airlift operations during the third quarter in connection with the Middle East crisis.

Higher energy prices are expected to have important effects on domestic production of crude oil, particularly in 1991. This will be especially true if oil producers perceive that the higher prices will persist beyond the next few months. In the $30-oil-price scenario, domestic crude oil output is projected to decline in 1990 by 330,000 barrels per day from 1989 levels. This compares to an average decline of 530,000 barrels per day in 1989. Higher oil prices are expected to further slow the rate of decline in domestic crude oil production by 1991.

In the $30-oil-price case, net imports of crude oil would be expected to increase by 360,000 barrels per day to 6.06 million barrels per day in 1990, compared to an increase of 750,000 barrels per day in 1989. The expected 1990 increase largely reflects the very high import rates during the first half of the year (particularly in the first quarter) compared with the same period in 1989. In 1991, net imports of crude oil are projected to decrease by 360,000 barrels per day. Refined petroleum product imports could are forecast to decline by about 320,000 barrels per day, resulting in the first decline in total petroleum net imports since 1985. Refinery utilization would also decline between 1990 and 1991, as reduced demands possibly lead to lower requirements from all supply sources.

In the $30-oil-price case, end-of-year crude oil inventories are projected to remain almost unchanged in both 1990 and 1991. The sizeable stock draw during the second half of 1990, brought about by the disruption of normal supply patterns, is projected to offset the unusual buildup of stocks during the first half of 1990. Refined petroleum product inventories, however, are expected to increase by about 73,000 barrels per day in 1990.

Energy in the Farm Sector

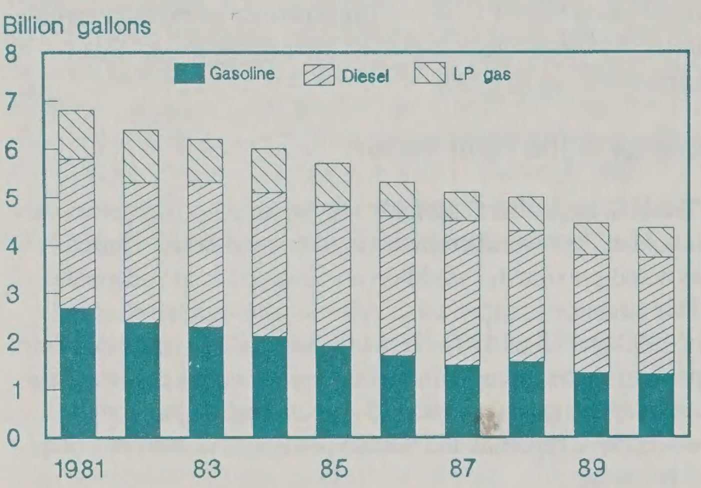
The U.S. agricultural sector's energy supply and price expectations reflect world crude oil market conditions. Currently, as noted previously, world crude oil supplies are adequate. This situation is expected to continue through the remainder of 1990 and all of 1991. If the price stabilizes at around $30 per barrel, the prices paid by farmers for various types of energy will be approximately 13 percent higher than they would have been had the $20.90 per barrel world price been maintained.

Little shift is expected on the input mix (e.g., fuel choice) over the next year or so. In the intermediate- to long-term, however, if the higher price of crude oil remains in effect, it is expected that farmers will begin substituting relatively less expensive energy (e.g., natural gas) for refined petroleum products (e.g, diesel fuel and gasoline) when and where substitutions are feasible. If $40 per barrel is realized, it is expected that the energy prices paid by farmers will be approximately 25 percent higher relative to the $20.90 per barrel price.

Higher prices for energy inputs will have several impacts throughout the farm sector. With the world price of crude oil at $30 per barrel, total farm production expenses for 1991 will rise by approximately 1 percent. Lower expenses for farm-origin inputs (e.g., feed, feeder livestock, and seed) will offset part of the rise in expenses for nonfarm-origin inputs (fuels and oil, electricity, fertilizer, and pesticides). Model results show that expenditures for farm-origin inputs will be lower because higher transportation costs associated with the higher price of crude oil will lead to reduced prices for livestock. Consequently, livestock production will be marginally lower as higher beef and pork production from the increased liquidation of the breeding herd partially offsets lower poultry production. As a result, feed demand is reduced, resulting in lower crop prices.

Additionally, if oil prices average $30 per barrel, net farm income is projected to fall 5.5 percent due to a reduction in cash receipts (mostly due to lower livestock receipts) coupled with the higher production expenses. Finally, the higher costs and lower net returns would encourage increased farmer participation in the agricultural commodity program. If the world price of crude oil averages $30 per barrel for 1991, increased participation in the agricultural commodity program is projected to cost the government an additional 0.6 percent.

Figure 1
Farm Fuel Use



1990 forecast.

Farm Fuel Use

The combined consumption of refined petroleum products, such as diesel fuel, gasoline and liquified petroleum gas by agriculture, has declined steadily since 1978 (figure 1). Although the number of acres planted influences farm energy use, other factors, including weather, are also important. For example, the switch from gasoline to diesel powered engines; conservation tillage practices; larger, multifunction machines; and innovations in crop drying and irrigation have contributed to this decline. While no-till and mulch-till farming practices have not yet been widely adopted, they are now as prevalent as conventional tillage practices in some parts of the United States.

With only a minimal increase in total cropland planted and harvested acres in 1990, with few significant changes in cropping practices, and with somewhat higher average prices for energy for the entire growing season, the data, when they become available (in 1991), are expected to show that 1990 farm energy consumption remained near its level for 1989.

Energy Prices and Expenditures Up in 1989; Higher Prospects for 1990 and 1991

Crude oil prices (especially imported, as the marginal supply in most instances) heavily influence the prices farmers pay for refined petroleum products, such as diesel fuel and gasoline. In 1989, average nominal (i.e., inflation impact included) gasoline prices increased by 13 percent and nominal diesel fuel prices rose by 4 percent over their 1988 levels (table 2). These gains can be attributed to refiners' higher costs of acquiring crude oil and reducing vapor emissions. A rise in average real (i.e., inflation effect netted out) energy prices of 6 to 9 percent are expected for 1990.

In 1989, farm energy expenditures for diesel fuel, gasoline, liquified petroleum gas, natural gas, and lubricants totaled $6.78 billion, down 4.5 percent from a year earlier (table 3). This reduction reflects no change in fuel and lubricant expenditures and about a 12 percent decline in electricity expenditures. Higher energy prices, slightly higher yields, increased acres planted and harvested, and more normal weather conditions in 1989 over 1988 combined to account for the observed declines. In 1990, a gain in planted and harvested acreage and a slight increase in acres irrigated, coupled with higher refined petroleum product prices in the fourth quarter are expected to raise energy expenditures to $7.24 billion, nearly 7 percent above 1989's reduced level. A further increase is forecast for 1991, if the price of crude oil is sustained at or increases above its current level.

The Budget Reconciliation Act (H.R. 5835) calls for a 5-cents-per-gallon increase in the federal excise tax on motor fuels to take effect on December 1, 1990. Since half of this increase is earmarked for the Highway Trust Fund (farmers are exempt from paying into this fund), farmers will have to pay only 2.5 cents per gallon more for diesel fuel and gasoline. This will amount to about a 1.5 percent increase in farm energy expenditures.

Table 2--Average U.S. farm fuel prices 1/

Year	Gasoline	Diesel	LP gas
	$/gallon 2/		
1981	1.29	1.16	0.70
1982	1.23	1.11	0.71
1983	1.18	1.00	0.77
1984	1.16	1.00	0.76
1985	1.15	0.97	0.73
1986	0.89	0.71	0.67
1987	0.92	0.71	0.59
1988	0.93	0.73	0.59
1989	1.05	0.76	0.58
1990			
January	1.09	1.01	1.06
April	1.08	0.81	0.67
July	1.10	0.74	0.65

1/ Based on surveys of farm supply dealers conducted by the National Agricultural Statistics Service, USDA. 2/ Bulk delivered.

Table 3--Farm energy expenditures

Item	1987	1988	1989	Forecast 1990
	$ billion			
Fuels and lubricants:				
Gasoline	1.37	1.42	1.44	1.45
Diesel	2.13	2.12	2.12	2.20
LP gas	0.38	0.38	0.38	0.39
Other	0.47	0.53	0.51	0.55
Electricity:				
Excluding irrigation	2.03	2.17	1.69	2.00
For irrigation	0.43	0.48	0.64	0.65
Total	6.81	7.10	6.78	7.24
Percent change from preceding year		4.25	-4.51	6.78

Source: U.S. Department of Agriculture, National Agriculture Statistics Service, Farm Production Expenditures, 1987, 1988, 1989 Summaries.

Farm Machinery

Demand

Expenditures for tractors and other farm machinery rose an estimated $1.5 billion in 1989 to $7.9 billion (table 4). This increase was due to the purchase of more machinery; especially more costly, larger horsepower tractors. Price increases also helped push up machinery expenditures.

The rise in expenditures for farm machinery and equipment continued in early 1990, but not as rapidly as from 1988 to 1989. However, unit sales of farm machinery slowed in August. Combines, and possibly mid-range tractors and mower conditioners, might end the year with fewer unit sales than in 1989. Farm income rose in 1987 and 1988, which encouraged farmers to invest in new machinery to replace aging equipment that, in some cases, had not been replaced for over a decade. In 1989, net cash income and government payments decreased from the previous year, which likely reduced the 1990 demand for farm machinery. Recent, sharp fuel price increases will further dampen farm machinery demand.

Positive factors affecting future farm machinery demand include reduced farm debt and increased asset values. Farm debt continued to decrease in 1989 as farmers paid off or renegotiated old loans. Asset values continued to rise, both for real estate and nonreal estate. Land values rose 4 percent in 1989, and the trend is expected to continue through 1990. The decline in debt and the rise in asset values caused the debt-asset ratio to fall in 1989, and it will likely fall again in 1990. With farmers' equity increasing because of a lower debt-asset ratio, lenders are more apt to lend money for equipment purchases.

Interest Rates Increase

The real interest rate (inflation adjusted) for farm machinery and equipment loans reached 8.7 percent in 1989—up from the 1988 rate of 8.4 percent. The nominal rate was 12.8 percent. These were both higher than the 1987 lows of 8.3 and 11.5 percent, respectively. While higher interest rates theoretically dampen the demand for farm machinery, other factors affecting demand, such as reduced debt and improved asset values, resulted in overall increases in 1989 farm machinery sales.

Table 4--Trends in U.S. farm investment expenditures and factors affecting farm investment demand

Item	1984	1985	1986	1987	1988	1989	Forecast 1990
				$ billion			
Capital expenditures:							
Tractors	2.54	1.94	1.51	2.10	2.41	2.8	2.6-3.0
Other farm machinery	4.68	3.23	3.09	4.26	4.03	5.1	4.8-5.3
Total	7.22	5.17	4.60	6.36	6.44	7.9	7.4-8.3
Tractor and machinery repairs	3.8	3.7	3.7	3.9	4.0	4.7	4.4-4.9
Trucks and autos	2.04	1.77	1.71	2.17	2.29	2.6	2.4-2.8
Farm buildings 1/	3.26	2.26	2.14	2.60	2.32	2.5	2.4-2.7
Factors affecting demand:							
Interest expenses	21.1	18.6	17.1	15.5	15.2	15	14-16
Total production expenses	142.7	131.7	125.1	127.7	131.8	143	144-148
Outstanding farm debt 2/ 3/	204	188	167	154	149	146	143-149
Farm real estate assets 2/	694	650	606	634	666	688	675-690
Farm nonreal estate assets 2/	209	186	181	191	205	215	211-227
Agricultural exports 4/	38.0	31.2	26.3	27.9	35.3	39.7	40.0
Net farm income	32.2	31.2	31.4	41.2	42.0	47	47-51
Net cash income	38.7	48.2	47.2	56.1	58.4	55	52-57
Direct Government payments	8.4	7.7	11.8	16.7	14.5	11	8-11
				Million acres			
Diverted acres 5/	27.0	30.7	48.1	76.2	77.7	60.8	59.9
				Percent			
Real prime rate 6/ 7/	8.3	6.9	5.7	5.0	6.0	6.8	5.4
Nominal farm machinery and equipment loan rate 8/	14.6	13.7	12.2	11.5	11.7	12.8	na
Real farm machinery and equipment loan rate 7/	10.8	10.7	9.4	8.3	8.4	8.7	na
Debt-asset ratio 9/	21.5	21.2	19.9	17.4	15.9	14.9	14-15

na = Not available.

1/ Includes service buildings, structures, and land improvements. 2/ Calculated using nominal dollar balance sheet data, including farm households for December 31 of each year. 3/ Excludes CCC loans. 4/ Fiscal year. 5/ Includes acres idled through commodity programs and acres enrolled in the Conservation Reserve Program. 6/ Monthly average. 7/ Deflated by the GNP Deflator. 8/ Average annual interest rate. From the quarterly sample survey of commercial banks: Agricultural Financial Databook, Board of Governors of the Federal Reserve System. 9/ Outstanding farm debt (including households) divided by the sum of farm (including households) real and nonreal estate asset values.

Source: Agricultural Income and Finance, Situation and Outlook Report, AFO-38, ERS; and other ERS sources.

Government Payments Decrease

Direct Government payments dropped 25 percent from 1988 to 1989 and could drop further in 1990. The payment reduction was largely the result of lower deficiency payments. For some farmers Conservation Reserve Program rental payments partially offset lower commodity payments for wheat, corn, and sorghum. Lower Government payments do not necessarily mean reduced demand for farm machinery. Increased revenues from crop and livestock sales may offset a reduction in Government payments. However, increased 1990 wheat production is resulting in sharply reduced wheat prices that do not bode well for machinery demand in that sector of the farm economy.

Unit Sales

Sales of farm machinery for the first eight months of 1990 were up slightly from the same period a year ago, but in September were down for most categories of farm machinery. With August and September combine sales down 20 percent, sales by the end of the year probably will be less than in 1989. The recovery of sales of larger tractors from the low levels of the mid-1980's will likely continue, but at a reduced rate of growth.

Tractor Sales Up

Sales of tractors in the higher horsepower ranges, as a share of all tractor sales, continued to rise. In 1989 four-wheel-drive tractors constituted 7 percent of reported tractor sales, compared with 5 percent in 1988 and 3 percent in 1987. By the end of 1990 four-wheel-drive tractors will be about 9 percent of total farm tractor sales. Sales of tractors in the 40 to 99 horsepower range increased from 30,718 units in 1987 to 34,910 units in 1989, but decreased as a percentage of total sales from 64 percent in 1987 to 59 percent in 1988. They are forecast to go down to 55 percent in 1990 (table 5).

The sales forecast for four-wheel-drive tractors—5,500 units for 1990—is down from the February forecast. The new forecast still represents a 32-percent gain from 1989. Increased sales of larger tractors may be due in part to a trend toward larger farms. Larger tractors handle larger implements and can cover more ground per pass. Four-wheel-drive tractors have less tire slippage and are thus more cost effective than two-wheel-drive tractors with higher horsepower.

Farm Tractor Trade

The Department of Commerce 1990 forecast of farm machinery and equipment export value is $2.7 billion. Imports are projected at $2.6 billion. If these forecasts become reality, 1990 will be the second consecutive year since 1985 that the value of farm machinery and equipment exports exceeded the value of imports. In 1985, exports were at $1.86 billion and imports were $1.56 billion. In 1988, imports exceeded exports by $300 million.

The farm tractor industry has undergone considerable change in the last several years. Not only has the U.S. industry become more concentrated, but it has also become more international. Of 14 tractor brands sold in the U.S. in 1990, 7 were produced in the United States. Production is concentrated in two U.S. firms. In 1990 nearly all tractors sold, under 100 horsepower, were manufactured in foreign countries including Argentina, Belgium, Brazil, Britain, France, Germany, Italy, Japan, Mexico, Poland, and Romania. Nearly all garden tractors are made in Japan. Tractors over 100 horsepower are still primarily produced in the United States.

Table 5--Domestic farm machinery unit sales

Machinery category	Annual average 1978-80	1985	1986	1987	1988	1989	Forecast 1990	Change 88-89	Change 89-90
	Units							Percent	
Tractors:									
Two-wheel-drive									
40-99 hp	62,818	37,847	30,848	30,718	33,154	34,910	35,000	5	0
100-139 hp	38,650	7,300	5,149	5,084	4,320	5,216	5,000	21	-4
Over 139 hp	20,893	10,400	9,313	10,818	11,802	15,369	18,000	30	17
Total over 99 hp	59,543	17,700	14,462	15,902	16,122	20,585	23,000	28	12
Four-wheel-drive	10,276	2,912	2,037	1,653	2,729	4,151	5,500	52	32
Grain and forage harvesting equipment:									
Self-propelled combines	29,834	8,411	7,660	7,172	5,995	9,110	8,000	52	-12
Forage harvesters 1/	11,145	2,460	2,164	2,280	2,406	2,801	3,200	16	14
Haying equipment:									
Mower conditions	23,392	11,243	10,898	11,239	11,043	13,152	12,700	19	-3

1/ Shear bar type.

Source: Historical data are from the Equipment Manufacturers Institute (EMI). All 1990 values are ERS forecasts.

Tillage Systems

Tillage operations and the amount of previous crop residue remaining after planting are important indicators of soil erosion potential. The conservation compliance provisions of the 1985 Food Security Act (FSA) require farmers to use conservation practices on highly erodible land (HEL) by 1995. Farmers must reduce erosion to a specified level or be ineligible for farm program benefits. The FSA states that a field designated as HEL must have a conservation plan approved by January 1, 1990, and that plan must be fully implemented by January 1, 1995. To meet these requirements, a change in crop rotation, a change in tillage system, the addition of a cropping practice (such as contouring), and/or the installation of permanent structures might be recommended. The USDA has developed plans for 135 million acres of HEL cropland. These plans include 100 million acres of conservation tillage as part of the recommendations.

The FSA states that if one-third or more of a field consists of highly erosive soils, the field is designated HEL. This leaves highly erosive soils in many fields designated non-HEL. The application of conservation practices to these non-HEL fields, although not required by the FSA, would also reduce soil erosion and improve water quality.

The tillage system employed influences the types and levels of other input use. Labor and fuel inputs are normally reduced by tillage systems that require fewer trips over the field. On the other hand, a no-till system used on sod or small grain acreage usually necessitates an extra herbicide application to kill the vegetation. Labor hours spent in tilling the soil are related to the number of times the farmer goes over the field, as well as implement size and tractor speed.

For erosion control purposes, a conservation tillage system is defined as one that leaves 30 percent or more of the soil surface covered with residue after planting. Conventional tillage methods (with and without the moldboard plow) leave less than 30 percent surface coverage. Since different tillage systems leave significantly different residue levels, the type of system directly affects erosion potential and water quality. In general, conventional tillage systems without the moldboard plow leave less than one-half as much residue after planting as mulch-till systems.

Table 6--Tillage practices used in winter wheat production, 1990

Category	AR	CO	IL	KS	MI	MT	NE	OH	OK	SD	TX	WA	Area
Harvested acres (1000)	1300	2550	1950	11800	2000	2600	2250	1350	6300	1700	4200	2200	40200
						% of acres 1/							
Highly erodible land	5	44	18	28	33	51	36	15	20	24	23	55	29
Tillage system:													
Conv/w mbd plow 2/	nr	7	id	15	1	4	11	18	30	5	2	6	12
Conv/wo mbd plow 3/	89	65	[illegible]	67	70	58	71	65	64	56	81	75	69
Mulch-till 4/	8	25	11	18	17	31	18	10	6	37	17	12	17
No-till 5/	3	3	8	id	11	7	nr	7	nr	3	nr	[illegible]	3
						% of soil surface covered							
Residue remaining after planting:													
Conv/w mbd plow	nr	1	id	2	id	2	2	2	2	2	2	2	2
Conv/wo mbd plow	12	15	18	14	17	15	17	15	12	17	12	14	14
Mulch-till	42	38	37	37	36	39	37	37	36	43	38	40	38
No-till	66	53	65	id	52	70	nr	60	nr	39	nr	15	53
Average	16	21	23	17	24	26	19	18	11	27	17	17	18
						Number							
Hours per acre:													
Conv/w mbd plow	nr	.7	id	.6	id	.8	1.1	1.3	.6	.5	.6	.4	.7
Conv/wo mbd plow	.3	.4	.3	.6	.3	.4	.6	.4	.6	.4	.6	.5	5
Mulch-till	.2	.4	.3	.4	.3	.2	.5	.3	.5	.2	.3	.4	.3
No-till	id	.1	.1	id	.1	.1	nr	.2	nr	.1	nr	.1	.1
Average	.3	.4	.3	.6	.3	.3	.6	.5	.6	.3	.5	5	.5
Times over field:													
Conv/w mbd plow	nr	6.2	id	5.7	id	4.1	5.9	4.4	5.1	4.7	5.8	5.4	5.3
Conv/wo mbd plow	3.4	5.9	2.5	5.6	2.6	4.9	5.4	2.7	5.0	5.2	5.2	6.0	5.0
Mulch-till	2.2	5.0	2.0	4.9	2.2	3.2	3.6	2.1	4.7	3.1	4.3	4.5	4.0
No-till	1.0	1.0	1.0	id	1.0	1.0	nr	1.2	nr	1.0	nr	1.0	1.0
Average	3.2	5.5	2.4	5.5	2.4	4.1	5.2	2.8	5.0	4.3	5.1	5.4	4.7

id = Insufficient data. nr = None reported.

1/ May not add to 100 due to rounding. 2/ Conventional tillage with moldboard plow--any tillage system that includes the use of a moldboard plow and has less than 30% residue remaining after planting. 3/ Conventional tillage without moldboard plow--any tillage system that has less than 30% remaining residue and does not use a moldboard plow.
4/ Mulch-tillage--System that has 30% or greater remaining residue after planting and is not a no-till system.
5/ No-tillage--No residue-incorporating tillage operations performed prior to planting; does allow passes of nontillage implements, such as stalk choppers.

Tillage system designations were determined from estimates of residue remaining after planting and the use (or nonuse) of specific implements. To obtain the residue estimate, the percent of residue remaining was estimated from the previous crop and reduced by the residue incorporation rate of each tillage and planting implement used. For this report, the percent of residue remaining after planting was assumed to be evenly distributed over the soil surface.

1990 Winter Wheat

Oklahoma reported the heaviest reliance on the moldboard plow among major winter wheat producing States in the 1990 Cropping Practices Survey (table 6). Montana and South Dakota reported that mulch tillage was used on more than 30 percent of winter wheat acreage. Compared to 1989 acreage, total use of the moldboard plow decreased, while other tillage types increased slightly.

South Dakota and Montana had the highest estimated percent residue remaining after planting (27 and 26 percent) because of extensive use of mulch-till and no-till methods. Oklahoma had the lowest (11 percent) because of greater use of conventional tillage methods. There was little change in average residue levels from 1989.

Little change in the number of trips over the field was reported, compared to 1989. Except for the no-till system, wheat acreage had more trips over the field than most other field crops. Much of the wheat produced in the Great Plains and western States is produced after a fallow period. All implement trips over the field made during the fallow year were included in determining residue levels. Typical fallow procedure starts in the fall with chisel plowing and other noninversion tillage operations, instead of a single pass with the moldboard plow. For these States, therefore, the tables reflect more trips over the field under conventional tillage without the moldboard plow. The recent increase in world oil prices will increase the cost of tillage operations. This might cause some producers to reduce the total number of trips over the field by switching to mulch-till or no-till practices.

An average of 29 percent of the 1990 surveyed winter wheat acreage was produced on HEL. This figure varied from about 5 percent in Arkansas to over 50 percent in Montana and Washington. The western States are usually more subject to wind erosion than to water erosion.

Table 7--Tillage practices used in fall potato production, 1989

Category	CO	ID	ME	MI	MN	NY	ND	OR	PA	WA	WI	Area
Planted acres (1000)	62	355	81	30	67	30	125	52	21	118	70	1011
					% of acres 1/							
With cover crop	5	2	25	75	15	50	16	7	38	13	47	18
Highly erodible land	44	31	13	12	4	3	5	34	19	14	6	21
Tillage system:												
Conv/w mbd plow 2/	34	37	40	48	20	89	21	24	87	33	72	39
Conv/wo mbd plow 3/	59	60	41	43	55	8	65	71	11	67	24	54
Mulch-till 4/	6	5	19	4	26	nr	14	5	nr	id	3	6
No-till 5/	nr	nr	nr	4	nr	id	nr	nr	2	nr	id	id
				% of soil surface covered								
Residue remaining after planting:												
Conv/w mbd plow	2	1	2	2	2	2	2	1	2	2	2	2
Conv/wo mbd plow	12	8	9	16	19	id	18	6	18	8	10	10
Mulch-till	39	39	36	37	44	nr	39	43	nr	id	37	39
No-till	nr	nr	nr	60	nr	id	nr	nr	id	nr	id	66
Average	10	7	11	12	22	4	17	7	5	6	5	9
					Number							
Hours per acre:												
Conv/w mbd plow	1.1	.8	1.1	.9	.6	1.1	.4	1.4	1.3	1.2	.8	.9
Conv/wo mbd plow	.9	.8	.9	.8	.5	.6	.5	1.1	1.0	1.0	.6	.8
Mulch-till	.9	.5	.7	.3	.3	nr	.3	.7	nr	id	.3	.5
No-till	nr	nr	nr	.2	nr	id	nr	nr	id	nr	id	.1
Average	1.0	.8	1.0	.8	.5	1.1	.4	1.1	1.2	1.1	.7	.8
Times over field:												
Conv/w mbd plow	3.9	4.2	3.7	3.8	4.1	3.3	4.7	5.3	3.8	4.6	3.7	4.1
Conv/wo mbd plow	4.4	4.7	3.5	3.8	4.5	5.0	4.4	5.1	3.1	5.0	3.7	4.5
Mulch-till	3.0	3.0	3.1	2.0	2.8	nr	2.9	3.1	nr	id	2.0	2.9
No-till	nr	nr	nr	1.0	nr	id	nr	nr	id	nr	id	1.0
Average	4.1	4.4	3.5	3.6	4.0	3.4	4.2	5.0	3.6	4.9	3.6	4.3

id = Insufficient data. nr = None reported.

1/ May not add to 100 due to rounding. 2/ Conventional tillage with moldboard plow--any tillage system that includes the use of a moldboard plow and has less than 30% residue remaining after planting. 3/ Conventional tillage without moldboard plow--any tillage system that has less than 30% remaining residue and does not use a moldboard plow.
4/ Mulch-tillage--System that has 30% or greater remaining residue after planting and is not a no-till system.
5/ No-tillage--No residue-incorporating tillage operations performed prior to planting; does allow passes of nontillage implements, such as stalk choppers.

Conventional tillage methods were used on 76 percent of the highly erodible acreage, with 8 percent using the moldboard plow and 68 percent not using the plow. These acres may meet conservation compliance requirements, because the entire rotation, timing of tillage operations, and other practices are used in the evaluation. The majority of Western winter wheat producers follow a wheat-fallow rotation. They usually begin the fallow period by roughening the soil by chisel or sweep plowing, leaving residue on the soil surface. This not only decreases wind erosion but helps retain water. Winter wheat is planted the following fall and plant growth provides protection during the next spring's period of highest wind erosion.

1989 Potatoes

In 1989 fall potato production, New York and Pennsylvania used the moldboard plow on over 85 percent of the acreage (table 7). Most of the other surveyed States used the plow on less than 50 percent. Minnesota, North Dakota, and Maine also reported a larger use of mulch-till (14 to 26 percent).

Wind erosion is often a problem on the flat, loamy-sandy soils utilized for potato production. Therefore, many of these soils are designated highly erodible. Cover crops may be utilized as erosion protection in the eastern States where water availability is not a major problem. However, other States may need to decrease the use of the moldboard plow and/or increase the use of mulch-till in their attempt to comply with erosion reduction objectives.

Seeds

Consumption

Seeding rates tend to change slowly from year to year, consequently the number of acres planted is the major determinant of seed consumption. For the 1989/90 crop year, seed use for the eight major field crops will likely equal 6.3 million tons; showing a 2 percent decline from the previous year, since planted acreage of these field crops is expected to be slightly lower than last year (table 8).

Prices

Most seed prices were boosted significantly in 1989 by greater demand resulting from increases in planted acreage, drought reduced seed supply, higher commodity prices, and increased cost of off-season seed production. In 1990, however, most field seed prices paid by farmers fell from the 1989 level, as seed supplies exceeded demand. For example, soybean and hybrid corn seed prices fell 15 and 2 percent, respectively, between 1989 and 1990 (table 9). However, prices for winter wheat seed, cotton seed, and potato seed were higher than last year.

Forage seed prices were also generally lower this year compared to 1989, as demand declined, due to decrease in the growth of Conservation Reserve Program acreage. Supply exceeding demand pulled forage seed prices down considerably. For example, timothy, fescue, and orchardgrass fell 38, 23, and 13 percent, respectively. USDA's prices paid index for seeds, at 163, declined 4.1 percent in 1990 following a 13 percent increase in 1989.

Seed Expenditures

In 1989, total farm seed expenditures rose 5 percent from 1988 to $3.86 billion (table 10). However seed expenditures for field crops and small grains — the largest component of

Table 8--Seed use for major U.S. field crops 1/

Crops	1986/87	1987/88	1988/89	1989/90 2/	Change 88/89-89/90
	1,000 tons				Percent
Corn	468	482	523	541	3
Sorghum	44	36	42	30	-28
Soybeans	1,653	1,684	1,766	1,695	-4
Barley	429	376	360	345	-4
Oats	608	505	433	379	-12
Wheat	2,520	2,550	3,090	3,057	-1
Rice	130	150	150	160	7
Cotton	93	106	89	103	16
Total	5,945	5,889	6,453	6,310	-2

1/ Crop marketing year. 2/ Preliminary.

Table 9--April farm planting seed prices 1/

Item	Unit	1988	1989	1990	Change 89-90
					Percent
Field seeds:					
Corn	2/	64.20	71.40	69.90	-2
Grain sorghum	$/cwt.	65.70	69.50	69.90	1
Oats	$/bu.	4.37	5.89	4.19	-29
Barley	$/bu.	4.58	5.91	5.25	-11
Wheat (spring)	$/bu.	5.89	6.71	6.05	-10
Wheat (winter)	$/bu.	6.57	7.55	8.01	[illegible]
Soybeans	$/bu.	11.90	14.70	12.50	-15
Cotton	$/cwt.	47.70	50.10	54.30	8
Potatoes	$/cwt.	7.12	10.60	11.00	4
Forage seeds:					
Red clover	$/cwt.	143.00	143.00	145.00	[illegible]
Fescue 3/	$/cwt.	71.80	111.00	85.10	-23
Orchardgrass	$/cwt.	116.00	117.00	102.00	-13
Ryegrass, annual	$/cwt.	47.90	54.30	50.50	-7
Timothy	$/cwt.	132.00	132.00	82.10	-38
Lespedeza, sericea	$/cwt.	275.00	167.00	134.00	-20
Alfalfa, proprietry	$/cwt.	245.00	249.00	253.00	2
Seed price paid index (1977=100)		150	170	163	-4.1

1/ Derived from the April survey of farm supply dealers conducted by the NASS, USDA. 2/ $/80,000 kernels. 3/ Tall, Alta, and Kentucky 31.

Table 10--U.S.farm expenditures for seeds 1/

Item	1985	1986	1987	1988	1989	Change 88-89
	Billion dollars					Percent
Field crops and small grains	3.17	2.70	2.46	2.49	2.77	11
Legumes, grasses, and forages	0.37	0.39	0.39	0.34	0.34	3
Seeds and plants for other crops	0.36	0.37	0.65	0.78	0.67	-14
Other seed expenses 2/	0.04	0.04	0.05	0.09	0.08	-11
Total seed expenditures	3.94	3.50	3.54	3.69	3.86	5

1/ Excludes bedding plants, nursery stocks, and seed purchased for resale. 2/ Includes seed treatment.

total seed expenditures (72 percent) — rose 11 percent. These increases in seed expenditures reflected substantially higher field seed prices and greater planted acreage. Farm seed expenditures might fall in 1990 due to lower seed prices and only modest expected increase in planted acreage.

1989 Fall Potato Seeding Rates and Seed Costs per Acre

Fall potato seeding rates vary, depending upon expected moisture availability during the growing season. Locations with abundant moisture " either through rainfall, as in the Northeast, or through irrigation, as in Colorado and the Pacific Northwest " tend to have higher seeding rates. North Central States (such as North Dakota, Minnesota, and Wisconsin) have lower seeding rates per acre, since most potatoes are grown without irrigation. The average seeding rate for the 11 leading potato producing States in 1989 was 20 cwt per acre, the same as in 1988 (table 11).

Table 11--Fall potato seeding rates, seed cost per acre, and percent purchased, 1989 1/

States	Acres planted	Rate per acre	Cost per acre 2/	Acres with purchased seed
	1,000	Cwt.	Dollars	Percent
CO	62	24	254	30
ID	355	20	154	92
ME	81	21	239	72
MI	30	21	254	68
MN	67	16	175	69
NY	30	24	314	73
ND	125	15	155	82
OR	52	22	213	90
PA	21	19	262	88
WA	118	22	223	99
WI	70	19	190	84
1989 Average	1,011	20	189	83
1988 Average	1,006	20	129	83

1/ States in survey planted 92 percent of the fall potato acreage in 1989. 2/ Based on data from those farmers who used purchased seed.

Table 12--Winter wheat seeding rates, seed cost per acre, and percent of seed purchased, 1990 1/

States	Acres planted	Rate per acre	Cost per acre 2/	Acres with purchased seed
	Thousands	Pounds	Dollars	Percent
Winter:				
AR	1,300	134	13.92	66
CO	2,550	4[illegible]	5.09	37
IL	1,950	108	14.62	58
KS	11,800	62	6.53	36
[illegible]	2,000	114	14.36	54
MT	2,600	58	5.82	32
NE	2,250	65	4.90	17
OH	1,350	133	14.44	63
OK	6,300	73	5.44	26
[illegible]	1,700	66	5.31	32
TX	4,200	72	9.06	41
WA	2,200	68	8.20	67
1990 average	40,200	74	8.61	39
1989 average	34,710	77	9.59	41
1988 average	32,830	75	7.67	53

1/ States listed harvested 80 percent of U.S. winter wheat acres in 1990. 2/ Based on data from those farmers who used purchased seed.

Seeding rates and seed prices primarily determine seed cost per acre. In 1989, the average seed cost per acre was $189, up 47 percent from a year earlier, as average potato seed price jumped 49 percent. Seed potato prices also vary by State. Variation in seed prices and seeding rates resulted in per-acre costs ranging from $154 in Idaho to $314 in New York.

Farmers used purchased rather than homegrown seed potatoes on 83 percent of the 1989 fall potato acres. In Colorado, only 30 percent of the acres were planted with purchased seed, the lowest among potato-growing States. Colorado producers tend to grow a large share of their own seed potatoes, which are one or two generations away from certified seed. States that had relatively smaller shares of purchased seed potatoes were Michigan (68 percent), Minnesota (69 percent), and Maine (72 percent). Maine has a law requiring that all commercial potatoes growers use certified seed, which is mostly purchased. However, Maine has a large number of certified seed potato growers who use their own seed potatoes.

1990 Winter Wheat Seeding Rates and Seed Costs per Acre

For the 1990 crop, the average winter wheat seeding rate was 74 pounds, down 4 percent from 1989, but close to the 1988 rate. The average cost was $8.61 per acre, down 10 percent from 1989 due to lower seeding rates per acre (table 12).

Seeding rates and seed costs varied considerably among surveyed States. Arkansas, Illinois, Ohio, and Missouri had higher seeding costs per acre, reflecting higher seeding rates. The remaining surveyed States, on the other hand, showed lower seeding rates and, as a result, lower seeding costs per acre. Farmers used purchased seed on 39 percent of the 1990 winter wheat acres, very close to the previous year when it averaged 41 percent.

U.S. Seed Exports and Imports

Corn Seed Exports

In 1989, U.S. field corn seed exports to some of the leading importing countries, by volume, declined sharply, due to drought-reduced supplies of corn seed. Exports to Turkey, Netherlands, Spain, Canada, Chile, Japan, and Greece declined 78, 67, 56, 44, 37, 20, and 11 percent, respectively, compared with 1988 (table 13).

However, corn seed exports to Mexico, Italy, France, and Argentina increased in 1989. Exports to Mexico, one of the important U.S. export markets, surged from 3,151 metric tons in 1988 to 10,205 metric tons in 1989. Mexico also suffered from severe drought in 1988, which sharply reduced its domestic corn seed production and necessitated greater imports, even at higher U.S. prices. Since Italy and France are

Table 13--U.S. corn seed exports by volume

Country	1987	1988	1989	Change 88-89	January-June 1989	January-June 1990	Change 89-90
	Metric tons			Percent	Metric tons		Percent
Canada	2,505	2,582	1,548	-44	1,241	3,171	156
Mexico	3,143	3,151	10,205	224	5,991	7,949	33
Chile	166	541	340	-37	73	62	-15
Argentina	699	808	1,215	50	10	18	80
France	2,542	2,439	2,873	18	761	1,982	160
Spain	2,049	4,134	1,836	-56	1,320	2,893	119
Italy	12,229	8,741	12,168	39	2,590	12,616	387
Netherlands	695	1,060	351	-67	71	264	272
Greece	1,894	2,251	1,999	-11	1,759	1,731	-2
Turkey	2,678	1,104	245	-78	245	59	-76
Japan	1,861	1,322	1,051	-20	726	473	-35
Subtotal	30,461	28,133	33,831	20	14,787	31,218	111
Total	32,412	33,547	36,857	10	16,410	37,195	127

Source: U.S. Department of Commerce, Bureau of the Census, Foreign Trade Division.

critical U.S. export markets, exporters had to meet their commitments despite reduced corn seed supplies. Increases in corn seed exports to Argentina appears to have been due to off-season corn seed production in Argentina by several seed companies to make up for reduced supplies. Increased exports to these countries, especially to Mexico, more than offset the combined declines in exports to other major trading partners. As a result, total U.S. corn seed exports, by volume, increased 10 percent in 1989 from 1988.

Unlike 1989, corn seed exports increased sharply in the first 6 months of 1990 because U.S. supplies were plentiful, due to favorable weather conditions, and demand abroad remained strong. Total corn seed exports to our major trading partners reached 31,218 metric tons in the first 6 months of 1990 " a jump of 127 percent over the corresponding period a year earlier.

Corn Seed Imports

The volume of U.S. corn seed imports rose in 1989 to supplement 1988 drought-reduced domestic supply. Four major suppliers " Canada, Chile, Hungary, and Argentina " supplied 92 percent of the total corn seed to the United States. Imports from these countries surged from 7,317 metric tons in 1988 to 20,918 metric tons in 1989 (table 14).

Traditionally, Canada has been the largest supplier of corn seed, while Argentina, Chile, and Hungary have exported widely varying quantities. In 1989, imports from Canada rose 97 percent, by volume, compared with 1988. Several companies grew corn seed in South America during the off-season and much of the production entered the United States in 1989. Imports from Chile soared to 7,000 metric tons in 1989 from 2,055 metric tons in 1988. Argentina supplied 2,457 metric tons of corn seed in 1989, although it had exported no corn seed to the United States in the previous 2 years.

Again, contrary to last year, the volume of corn seed imports declined drastically during the first 6 months of 1990 compared to the corresponding period of 1989. Total U.S. corn seed imports equalled 11,337 metric tons in the first 6

Table 14--U.S. corn seed imports by volume

Country	1987	1988	1989	Change 88-89	January-June 1989	January-June 1990	Change 89-90
	Metric tons			Percent	Metric tons		Percent
Canada	4,465	3,935	7,753	97	3,711	5,356	44
Argentina	0	0	2,457	in	2,457	511	-79
Chile	67	2,055	7,000	241	7,000	4,509	-36
Hungary	196	1,327	3,708	179	3,708	881	-76
Subtotal	4,728	7,317	20,918	186	16,876	11,257	-33
Total	4,754	7,909	22,672	187	18,606	11,337	-39

in = Inapplicable.

Source: U.S. Department of Commerce, Bureau of the Census, Foreign Trade Division.

Table 15--U.S. soybean seed exports by volume

Country	1987	1988	1989	Change 88-89	January-June 1989	January-June 1990	Change 89-90
	Metric tons			Percent	Metric tons		Percent
Canada	6,087	293	390	33	342	444	30
Mexico	12,630	8,922	100,380	1025	70,880	31,343	-56
France	1,404	2,147	1,698	-21	1,196	2,689	125
Italy	44,348	27,833	20,185	-27	14,266	40,422	183
Turkey	5,038	3,798	2,777	-27	2,777	2,598	-6
Japan	4,151	5,277	1,608	-70	126	1,697	1,246
Subtotal	73,658	48,270	127,038	163	89,587	79,193	-12
Total	75,164	53,730	128,582	139	90,398	82,891	-8

Source: U.S. Department of Commerce, Bureau of the Census, Foreign Trade Division.

months of 1990, registering 39 percent decline over the same period a year earlier, as the domestic seed stocks were replenished.

Soybean Seed Exports

In 1989, volume of soybean seed exports to major importers, except Mexico, declined, as the 1988 drought sharply reduced U.S. soybean seed supplies. Exports to Italy, France, Turkey, and Japan " some of the leading U.S. trading partners " fell 27, 21, 27, 100, and 70 percent, respectively, in 1989 from the previous year (table 15).

Despite lower U.S. supplies and higher seed prices, soybean seed exports to Mexico in 1989 climbed to 100,380 metric tons, from 8,922 metric tons in 1988. The surge in exports to Mexico more than offset the combined declines in exports to other major importers. As a result, total U.S. soybean exports to six major trading partners jumped from 48,270 metric tons in 1988 to 127,038 metric tons in 1989, an increase of 163 percent. Without this increase to Mexico, U.S. soybean seed exports would have declined 27 percent.

Soybean seed exports to Italy, France, and Canada " some of the major U.S. importers " rose 183, 125, and 30 percent, respectively, in the first 6 months of 1990 over the same period a year earlier. These combined increases, however, were overshadowed by a 56 percent decline in exports to Mexico, resulting in a decline of 8 percent in total U.S. exports. Although the U.S. exports to Mexico during the first 6 months of 1990 fell sharply from the unprecedented level of 1989, they were still well above the levels typically exported to Mexico in earlier years.

Total Exports

The value of total seed exports rose 20 percent to $510 million in 1989 from a year earlier (table 16). This increase primarily reflects gains in soybean, grain sorghum, flower, and tree and shrub exports, which rose 108, 90, 22, and 33 percent, respectively. These gains were partly offset by declines of 50 percent and 8 percent in sugarbeet and vegetable seed exports, respectively.

Table 16--Exports and imports of U.S. seed for planting 1/

Item	1986	1987	1988	1989	Change 88-89
	$ million				Percent
Exports:					
Forage	74	75	94	96	2
Vegetable	128	138	167	153	-8
Flower	9	8	9	11	22
Corn 2/	77	63	67	68	1
Grain sorghum	29	16	29	55	90
Soybean	19	36	26	54	108
Tree/shrub	2	2	3	4	33
Sugarbeet	2	1	2	1	-50
Other	31	33	27	68	152
Total	371	372	424	510	20
Imports:					
Forage	39	65	52	43	-17
Vegetable	42	49	58	56	-3
Flower	18	21	21	24	14
Corn 3/	9	5	10	37	270
Tree/shrub	1	1	2	2	0
Other	3	2	5	6	20
Total	112	143	148	168	14
Trade balance	258	229	276	342	24

1/ Totals may not add due to rounding. 2/ Not sweet, not food aid. 3/ Certified.

Source: U.S. Department of Commerce, Bureau of the Census, Foreign Trade Division.

Mexico, Italy, Japan, Canada, Netherlands, and France continued to be the top markets for U.S. planting seeds in calendar year 1989. However, Saudi Arabia, for the first time, imported 11 percent of the total U.S. seed export value in 1989. These countries together accounted for 71 percent of the total export values (table 17). Mexico (26 percent) held first position, followed by Italy (11 percent), Saudi Arabia (10 percent), Japan (9 percent), Canada (6 percent), Netherlands (4 percent), and France (4 percent). On regional basis, North and Central America, Western Europe, and Asia typically accounted for about 90 percent of the total value of seed exports.

Total Imports

Total seed imports reached $168 million in 1989, up 14 percent from a year earlier. These gains can be largely attributed to a 270 percent increase in corn seed imports. U.S. corn seed imports rose sharply in 1989 to make up for the drought-reduced supplies of 1988. These gains were partly offset by a 17 percent decline in forage seed imports. The net U.S. seed trade balance surged 24 percent to $342 million in 1989 from a year earlier level (table 16).

In calendar year 1989, Canada continued to be the leading U.S. supplier of planting seeds, with 27 percent of the total seed imports (table 18). Chile, with 13 percent, was the sec-

Table 17--Export values for U.S. seeds for planting; region and country share 1/

Region/country	1985	1986	1987	1988	1989
	Percent				
North and Central America:					
Canada	7.4	6.3	9.4	8.4	6.2
Mexico	15.1	12.4	13.0	12.8	25.7
Others	2.5	2.0	2.3	2.2	1.8
Total	25.0	20.7	24.7	23.3	33.7
South America:					
Brazil	1.1	1.1	1.2	1.2	0.6
Argentina	1.1	2.5	2.5	3.0	2.1
Colombia	0.8	1.0	0.9	1.1	0.6
Venezuela	2.9	3.0	1.4	3.4	0.6
Others	1.1	1.3	1.5	1.6	1.4
Total	7.0	9.0	7.6	10.2	5.3
Western Europe:					
United Kingdom	2.7	2.8	2.6	2.9	2.6
Netherlands	4.6	5.8	5.4	4.5	4.2
France	9.6	6.2	4.5	4.6	3.8
West Germany	1.8	1.7	1.6	1.5	1.3
Spain	1.4	1.6	2.1	4.4	2.9
Italy	12.5	12.7	19.3	12.5	11.3
Greece	1.9	2.3	1.3	1.8	1.0
Others	3.1	3.4	2.8	3.2	2.5
Total	37.5	36.5	39.7	35.4	29.6
Eastern Europe:					
Hungary	2.9	0.6	0.1	0.4	0.3
Bulgaria	0.0	3.0	0.0	0.0	0.0
Others	0.4	1.2	0.1	0.8	0.4
Total	3.3	4.8	0.2	1.3	0.7
Asia:					
Turkey	1.3	3.0	2.0	1.0	1.5
Iraq	2.5	2.2	1.8	2.4	1.2
Saudi Arabia	2.8	3.6	2.0	4.2	10.5
Japan	10.7	9.6	12.3	11.9	8.9
South Korea	0.8	0.9	1.0	1.0	0.7
Others	3.8	4.6	3.6	4.2	3.5
Total	21.9	23.9	22.6	24.7	26.3
Africa:					
South Africa	0.8	1.2	1.5	1.1	1.2
Egypt	1.0	0.6	0.8	0.8	0.8
Others	1.1	1.4	0.7	1.0	0.8
Total	2.9	3.2	3.0	3.0	2.8
Oceania:					
Australia	2.0	1.6	1.8	1.7	1.2
New Zealand	0.4	0.3	0.3	0.3	0.3
Others	0.0	0.0	0.1	0.0	0.0
Total	2.4	1.9	2.2	2.0	1.6
Total	100.0	100.0	100.0	100.0	100.0

1/ Totals may not add due to rounding.

Table 18--Import values for U.S. seeds for planting; region and country share 1/

Region, country	1985	1986	1987	1988	1989
	Percent				
North and Central America:					
Canada	26.7	35.1	37.7	30.4	27.0
Mexico	4.0	2.9	2.0	2.1	3.0
Guatemala	2.3	2.7	2.5	2.4	2.3
Costa Rica	4.8	2.6	2.1	0.7	0.9
Others	0.6	0.1	0.1	0.1	0.0
Total	38.5	43.4	44.4	35.8	33.2
South America:					
Chile	8.2	6.2	4.0	6.8	13.3
Argentina	0.0	0.0	1.5	0.7	4.0
Others	1.0	0.8	0.5	0.8	0.4
Total	9.2	7.0	6.0	8.3	17.6
Western Europe:					
Denmark	1.6	1.2	2.1	1.9	1.5
United Kingdom	0.8	0.6	0.8	0.6	0.5
Netherlands	11.7	10.5	10.2	9.2	8.8
France	1.4	1.1	1.7	1.0	1.3
West Germany	1.4	2.2	2.5	2.2	1.8
Italy	1.7	1.1	1.2	1.6	1.0
Others	2.4	1.9	0.7	0.3	1.4
Total	21.0	18.7	19.2	16.8	16.3
Eastern Europe:					
Yugoslavia	1.4	0.0	0.0	0.0	0.0
Romania	0.2	0.1	0.0	0.0	0.2
Hungary	0.0	0.0	0.0	1.2	3.1
Others	0.2	0.4	0.5	0.1	0.1
Total	1.8	0.4	0.5	1.3	3.3
Asia:					
India	3.3	6.5	2.9	7.5	3.5
Thailand	0.0	0.0	0.7	1.6	2.8
Taiwan	7.6	6.0	6.7	4.5	6.2
Japan	6.1	6.1	6.0	6.4	6.9
China (Mainland)	0.0	0.0	0.0	2.4	3.9
Others	3.0	3.6	3.1	2.0	1.5
Total	20.1	22.2	19.4	24.5	24.9
Africa:					
Ethopia	4.4	2.8	3.0	3.3	0.1
South Africa	0.9	0.5	0.1	0.5	0.0
Others	1.0	0.6	0.8	0.0	0.6
Total	6.4	4.0	3.9	3.8	0.7
Oceania:					
Australia	2.2	1.8	2.1	1.8	1.6
New Zealand	0.8	2.6	4.5	5.6	2.4
Others	0.0	0.0	0.0	0.0	0.0
Total	3.0	4.3	6.5	7.4	4.0
Total	100.0	100.0	100.0	97.[illegible]	100.0

1/ Totals may not add due to rounding.

ond largest source, followed by the Netherlands (9 percent), and Japan (7 percent). The Netherlands has traditionally been the second leading supplier of seeds, but slipped to third position in 1989. Taiwan supplied 6 percent of 1989 total seed imports.

Fertilizer

The crisis in the Middle East leaves many unanswered questions for the fertilizer industry and U.S. farmers. U.S. fertilizer supplies in 1991 should be adequate for anticipated demand, but at higher prices.

The enormous increase in the price of crude oil since August 1990 (over 50 percent) has already impacted the fertilizer industry. The major production cost of anhydrous ammonia is its feedstock, which is natural gas, fuel oil, or gas from refineries. Anhydrous ammonia is used to produce other nitrogen-based fertilizer products. Since July 1990, the Gulf Coast wholesale price of anhydrous ammonia has increased over 30 percent, and urea 15 percent.

Wholesale prices of other fertilizers have also increased over the same period, but these price increases have been more in line with yearly, seasonal price variations. A recent USDA analysis of higher oil prices ($30 to $40 a barrel) and farm income showed that, as a result of the Middle East crisis, the cost of fertilizer in 1991 might increase from 4 to 7 percent over what it would have been without the crisis. Higher transportation costs will also add to the increase in fertilizer prices.

Consumption

U.S. plant nutrient use is estimated to have increased to 20.1 million tons during the 1989/90 fertilizer year (July 1-June 30), up 3.5 percent from the 19.6 million tons used a year earlier. Most of the increase was due to additional corn and wheat plantings. Corn acreage, which accounted for an estimated 44 percent of plant nutrient use in 1988/89, rose 3 percent; wheat acreage, which accounted for another 15 percent of nutrient use, increased by 1 percent (table 19).

Table 19--U.S. planted crop acreage

Crop	1989	1990	Change
	Million acres		Percent
Wheat	76.6	77.3	1
Feed grains	106.2	103.9	-2
Corn	72.3	74.5	3
Other 1/	33.9	29.4	-13
Soybeans	60.7	57.7	-5
Cotton	10.6	12.3	16
Rice	2.7	2.9	5

1/ Sorghum, barley, and oats.

Spring 1990 fertilizer prices were less than year-earlier levels. Supplies exceeded demand, since planted acres did not increase as much as anticipated. Target prices and most loan rates were reduced from year earlier levels. The April 1990 index of prices received by farmers for all crops was 7 percent less than 1989. In contrast, cotton prices increased slightly due to reduced stocks.

1990 Fertilizer Use on Winter Wheat

Fertilizer was applied to 84 percent of the winter wheat acres harvested in 1990 (table 20), down over 3 percent from the previous year. The proportion of acres treated with nitrogen, phosphate, and potash fell to 84, 48, and 18 percent, respectively. Nitrogen and phosphate per-acre application rates decreased to 62 and 38 pounds, while the application rate for potash increased one pound to 57. Arkansas acreage received the most nitrogen per acre at 100 pounds, while Illinois had the highest application rates for phosphate and potash at 74 and 91 pounds per acre, respectively. The least amount of nitrogen per acre (35 pounds) was applied in South Dakota.

1989 Fertilizer Use on Fall Potatoes

Some fertilizer was applied to 99 percent of the acreage planted to fall potatoes in 1989; the proportion of acres treated ranged from 98 percent for nitrogen to 83 percent for potash (table 21). Application rates for the three nutrients varied significantly by State, averaging 192 pounds per acre for nitrogen, 157 pounds for phosphate, and 155 pounds for potash. North Dakota acreage received the least amount of all fertilizer nutrients, while Washington and Wisconsin received the most.

1989 Use of Manure, Lime, Sulfur, and Micronutrients

Manure was applied to 15 percent of all corn acres surveyed in 1989 (table 22). Use ranged from 40 percent in Wisconsin to 4 percent in Missouri. Manure use on other crop acreage surveyed was less common, ranging from 5 percent for soybeans to less than 1 percent for rice. Micronutrient use also varied considerably by crop; over half of the potato acres planted received micronutrients in 1989, while only 2 percent of the wheat acres were similarly treated.

Using lime to balance a soil's pH (a measure of its acidity or alkalinity) increases the yield potential of crops by improving the availability of soil nutrients. The frequency of lime applications can range from every year on highly acidic soils to every 5-10 years on the less acidic soils in the Midwest. Lime was applied to 5 percent of the corn acres surveyed in 1989, but no lime was used on rice or durum wheat. Lime application rates ranged from 1.9 tons per acre for winter wheat to 1.0 tons for potatoes.

Like other essential nutrients, sulfur plays a unique role in plant growth. Plants deficient in sulfur are often small and

Table 20--Fertilizer use on winter wheat, 1990

State	Acres 1/	Fields in survey	Acres receiving: Any ferti-lizer-	Acres receiving: N	Acres receiving: P205	Acres receiving: K20	Application rates: N	Application rates: P205	Application rates: K20	Proportion fertilized: At or before seeding	Proportion fertilized: After seeding	Proportion fertilized: Both
	Thousand	No.	Percent				Pounds			Percent		
Arkansas	1,300	67	100	100	31	31	100	41	55	8	62	30
Colorado	2,550	86	65	64	18	nr	41	22	nr	80	13	7
Illinois	1,950	66	100	100	90	79	85	74	91	16	9	75
Kansas	11,800	242	89	[illegible]	44	9	49	29	21	63	10	27
Missouri	2,000	72	96	96	78	83	84	51	71	32	17	51
Montana	2,600	94	76	76	67	18	47	28	17	77	6	17
Nebraska	2,250	84	79	79	22	2	50	27	#	74	16	9
Ohio	1,350	72	99	97	95	90	75	66	70	17	5	78
Oklahoma	6,300	157	91	91	62	10	65	34	25	58	4	38
South Dakota	1,700	72	41	41	26	3	35	24	#	51	35	15
Texas	4,200	162	66	66	35	5	[illegible]	37	10	66	13	21
Washington	2,200	105	98	98	33	1	65	19	2	87	3	11
Area	40,200	1,279	84	84	48	18	62	38	57	57	12	31

= Insufficient data. nr = None reported.

1/ Acres harvested for winter wheat.

Table 21--Fertilizer use on fall potatoes, 1989

State	Acres planted	Fields in survey	Acres receiving: Any ferti-lizer-	Acres receiving: N	Acres receiving: P205	Acres receiving: K20	Application rates: N	Application rates: P205	Application rates: K20	Proportion fertilized: At or before seeding	Proportion fertilized: After seeding	Proportion fertilized: Both
	1,000	No.	Percent				Pounds per acre			Percent		
Colorado	62	64	89	89	[illegible]	78	184	185	69	[illegible]	2	93
Idaho	355	274	99	99	93	70	202	151	98	32	7	61
Maine	81	144	100	100	100	100	168	180	181	93	0	7
Michigan	30	97	99	99	94	96	134	131	228	38	0	63
Minnesota	67	117	99	97	97	91	87	94	136	90	0	10
New York	30	32	100	100	100	100	142	217	192	77	0	23
North Dakota	125	125	98	94	98	92	85	74	58	91	0	9
Oregon	52	133	99	99	99	83	301	217	216	26	21	53
Pennsylvania	21	85	100	100	96	100	153	121	122	71	0	29
Washington	118	174	100	100	95	93	286	218	241	29	5	66
Wisconsin	70	116	99	99	97	97	205	147	343	17	0	83
Area	1,011	1,361	99	98	94	83	192	157	155	47	4	49

spindly, and in legumes, such a deficiency can reduce root nodulation. Sulfur use was more common than lime on all crops surveyed except soybeans. Sulfur use was most prevalent on fall potatoes; calcium sulfate is frequently applied to potatoes to extend their storage life. Forty-eight percent of potato acres surveyed received an average of 61 pounds of sulfur per acre in 1989.

Regulatory Action

The Environmental Protection Agency (EPA) ruling which prohibits phosphogypsum transport and use, including agricultural field applications, was scheduled to go into effect March 15, 1990 (peanut farmers have long used gypsum as a soil amendment). EPA first granted and then extended a temporary waiver allowing for agricultural uses until June 1, 1991. EPA then provided a 60 day comment period, solicited comments regarding four proposals for revising standards of phosphogypsum use, and held a hearing on May 3-4, 1990. Results of the hearing are still pending.

Table 22--Manure, lime, sulfur, and micronutrient use on selected crops, 1989

Crop	Acres 1/	Acres receiving: Manure	Acres receiving: Lime	Acres receiving: Sulfur	Acres receiving: Micro-nutrients	Application per acre: Lime	Application per acre: Sulfur
	1,000	Percent				Tons	Pounds
Corn	57,900	15	5	8	11	1.4	9
Cotton	8,444	2	2	21	15	1.3	23
Potatoes	1,011	4	7	48	52	1.0	61
Rice	[illegible],085	*	nr	5	13	nr	17
Soybeans	51,130	5	6	2	3	1.5	10
Wheat:							
All	54,290	3	1	7	2	1.9	12
Durum	3,000	2	nr	1	nr	nr	nr
Spring	16,580	3	*	4	*	nr	9
Winter	34,710	3	2	9	2	1.9	15

nr = None reported. * = Less than 0.5 percent.

1/ Includes the major producing States for each crop. Information is based on harvested acres for winter wheat and planted acres for all other crops.

The four proposals include redefining the term phosphogypsum and establishing a threshold concentration level of radium; allowing its use for research geared toward radium removal; allowing alternative uses of phosphogypsum in specific cases; or making no change to the rule. If the rule is unchanged, disposal of the byproduct would be restricted

to mounds or pits and all research or alternative uses, including agricultural uses after June 1, 1991, would be prohibited.

Supplies

The U.S. Department of Commerce (DOC) discontinued the reporting of anhydrous ammonia import and export data during calendar year 1989 because of a filed disclosure complaint by a fertilizer importer. Effective January 1990, DOC reinstated the reporting of anhydrous ammonia quantity data for all countries except imports from the U.S.S.R. Consequently, 1988/89 nitrogen supplies include only that share of anhydrous ammonia imported and exported during July-December 1988; and 1989/90 supplies include data only for January-June 1990, minus imports from the U.S.S.R. Anhydrous ammonia accounts for about 30 percent of total U.S. nitrogen imports and more than 20 percent of nitrogen exports. Anhydrous ammonia imports from the U.S.S.R. represent a large portion of anhydrous ammonia imports. Thus, nitrogen imports, exports, and domestic supply are significantly understated in this report.

Domestic supplies of phosphate in 1989/90 declined from a year earlier. Phosphate supplies fell 7 percent because of reduced domestic production and increased exports (table 23). Potash supplies increased by 7 percent because both domestic production and Canadian imports increased.

Table 23--U.S. fertilizer supplies 1/

Item	1988/89	1989/90	Change
	Million short tons		Percent
July 1 inventory:			
Nitrogen	1.35	1.51	12
Phosphate 2/	.55	.70	27
Potash	.16	.22	38
Production:			
Nitrogen	14.02	13.58	-3
Phosphate 2/	11.72	11.71	-1
Potash	1.63	1.83	12
Imports:			
Nitrogen	3/ 3.21	3/ 2.43	-24
Phosphate 2/	.07	.07	0
Potash	4.07	4.16	3
Exports:			
Nitrogen	3/ 2.72	3/ 2.95	8
Phosphate 2/	4/ 4.80	4/ 5.49	14
Potash	.40	.39	-3
Domestic supply: 5/			
Nitrogen	3/ 15.86	3/ 14.57	-8
Phosphate 2/	4/ 7.54	4/ 6.99	- 7
Potash	5.46	5.82	7

1/ Data for July through June for the fertilizer year starting July 1. 2/ Does not include phosphate rock. 3/ Does not include imports or exports of anhydrous ammonia during Calendar year 1989 or imports from the U.S.S.R. in 1990. Anhydrous ammonia import and export reports were discontinued by the U.S. Department of Commerce in 1989, but were reinstated in 1990, except imports from the U.S.S.R. Anhydrous ammonia accounts for about 30 percent of total nitrogen imports and over 20 percent of nitrogen exports; thus, nitrogen imports, exports, and and domestic supply are significantly understated. Also, aqua ammonia imports include only calander year 1989 and January-June 1990 data. 4/ Does not include exports of superphosphoric acid during July-December 1988/89 because of a data reporting change by the U.S. Department of Commerce. Thus, phosphate exports are understated and domestic supply is overstated. 5/ Includes requirements for industrial uses.

Trade

The rapid growth in domestic and international purchases of fertilizer materials in the first 6 months of fertilizer year 1989/90 (June-December 1989) has not continued. Some slowdown in purchases was expected following the excessive inventory build-up, which resulted from heavy buying towards the close of 1988 and spring of 1989. This was prompted by anticipation of strong domestic and international demand in the spring of 1990.

U.S. phosphate exports (nutrient content) during July 89-June 90 increased 14 percent. Potash exports were off by 3 percent from a year earlier. The decline in potash exports follows a 17-percent drop from 1987/88 to 1988/89.

The volume of fertilizer materials exported from the United States varied when compared with year-earlier levels. For July 89-June 90, diammonium phosphate exports climbed 14 percent from 7.9 to 9.0 million tons, and monoammonium phosphate exports increased 6 percent from 862,000 to 917,000 tons. Phosphate rock exports decreased 16 percent from 10.0 to 8.3 million tons.

Nitrogen solution exports, although still much higher than earlier years, declined 37 percent from 680,000 in 1988/89 to 429,000 tons in 1989/90. Urea exports increased 22 percent from 1.0 to 1.2 million tons, and concentrated superphosphate exports dropped 1 percent from 740,000 to 731,000 tons. Exports of ammonium nitrate and ammonium sulfate increased 130 and 11 percent, respectively, while potassium chloride and potassium sulfate decreased 11 and 9 percent.

France, Belgium, Italy, India, Japan, China, Pakistan, Korea, Mexico, and Brazil continued to be major recipients of U.S. fertilizer. During July 89-June 90, over 32 percent of urea exports and 30 percent of diammonium phosphate exports" representing 404,000 and 2.8 million tons of product, respectively" went to China. Fertilizer consumption in China has grown rapidly during the past few years, making it the world's third largest consumer of manufactured fertilizer nutrients after the U.S.S.R. and the United States. India received another 26 percent of DAP exports.

U.S. exports of urea to the European Community (EC) have become less competitive since the change in the anti-dumping ruling of February 1989. The EC softened its anti-dumping ruling for several countries that provided assurances about quantities exported to EC nations. However, none of the U.S. duty decisions made during the case were changed, since U.S. companies could state only their own and not any

other U.S. party's export intentions. All of the adjusted measures are now definitive until the rulings expire at the end of 1992 (for 1987 rulings) and at the beginning of 1994 (for 1988/89 rulings).

Belgium-Luxembourg and France remain important buyers of U.S. nitrogen solutions, receiving 227,000 and 196,000 tons (99 percent) of these exports during July-June. Brazil received 274,000 tons or 29 percent of ammonium sulfate exports, and 127,000 tons or 30 percent of potassium muriate exports. Chile received 165,000 tons or 23 percent of concentrated superphosphate exports. Phosphate rock exports have remained high, with Mexico, South Korea, Canada, Japan, the Netherlands, France, and Poland being the major recipients.

Potassium chloride imports during July-June were up 2 percent from a year earlier to 6.7 million tons, and diammonium phosphate imports increased 20 percent from 13,000 to 15,000 tons. Ammonium nitrate imports were up 7 percent from 414,000 to 443,000 tons, and ammonium sulfate imports jumped 18 percent from 357,000 to 422,000 tons. Imports of potassium chloride from Canada remained strong at around 94 percent of the total, and those from Israel increased 16 percent from 287,000 to 334,000 tons.

Fertilizer material imports for many products were less than year-earlier levels. Urea imports decreased 14 percent from 2.2 to 1.9 million tons, with Canada supplying about 67 percent of the total. Nitrogen solution imports decreased 23 percent from 632,000 to 489,000 tons. Imports of potassium sulfate and potassium nitrate also decreased.

Production

Domestic nitrogen and phosphate fertilizer production decreased during 1989/90 in response to lower prices and less than anticipated use, while potash production increased. Nitrogen production decreased 3 percent during July-June because some anhydrous ammonia producers operated at less than capacity or closed down for a period of time. Phosphate production decreased 1 percent in response to lower product demand and prices. Potash production increased 12 percent in response to increased export demand.

Prices

Spring 1990 fertilizer prices rose 1 percent from October 1989, following a 9 percent drop from the previous April (table 24). Aggregate farm fertilizer prices in spring 1990 were 8 percent less than a year earlier. Supplies (production, plus imports, plus inventory carry-over) during the summer and early fall of 1989 exceeded demand and pushed prices down. The 1990 anticipated planted acres did not increase as much as expected, resulting in only modest increases in fertilizer prices between the fall of 1989 and spring of 1990. Weather conditions (excessive flooding in the South and heavy rains in the Midwest) limited planting and fertilizer application for some crops.

Table 24--April farm fertilizer prices 1/

Year	Anhydrous ammonia (82%)	Triple super-phosphate (44-46%)	Diammonium phosphate (18-46-0%)	Potash (60%)	Mixed (6-24-24%)	Prices paid index 1977=100
	Dollars per short ton					
1986	225	190	224	111	179	125
1987	187	194	220	115	176	117
1988	208	222	251	157	208	132
1989	224	229	256	163	217	141
1990	199	201	219	155	198	130

1/ Derived from the April survey of farm supply dealers conducted by the NASS, USDA.

Nitrogen prices showed the greatest gain since last fall, with anhydrous ammonia prices climbing more than 10 percent by April, due to increased domestic use. Prices of other nitrogen materials either remained constant or increased from 1 to 7 percent. Triple superphosphate decreased 1 percent and diammonium phosphate prices went up less than 1 percent. Potash prices also increased slightly; the price of potassium chloride reached $155 per ton in April.

Since Iraq invaded Kuwait, domestic and international wholesale fertilizer prices have increased in anticipation of tighter fertilizer supplies and increased cost of production. However, despite the upward movement in prices, current world fertilizer supplies appear adequate for anticipated 1991 demand.

Pesticides

Consumption

Total 1990 farm pesticide use on major field crops is projected at 464 million pounds active ingredients (a.i), up 1.5 million from 1989 (table 25). June planted acreage for the 10 major field crops declined from 260 million in 1989 to 257 million. The area planted to corn, cotton, and wheat went up, while acreage of grain sorghum, soybeans, and barley and oats declined. Peanut, rice, and tobacco acreage held steady at year-earlier levels.

Compared with 1989, herbicide use declined, insecticide use increased, and fungicide use held fairly steady. The one million pound drop in herbicide use occurred because the decrease in soybean acreage more than offset the increase in corn acreage. Corn and soybeans accounted for 82 percent of herbicide consumption on field crops in 1990. Insecticide use grew 2.5 million pounds, largely on the strength of the 1.9 million increase in cotton acreage in 1990. Peanuts accounted for 80 percent of the fungicides used on major field crops.

Prices

Herbicide and insecticide prices have shown a general rise over the past 3 years (table 26). Pesticide manufacturing costs have gone up and dealer costs (especially liability insurance) also have risen. The recent increase in world oil prices will further push up raw material and transportation costs, putting additional upward pressure on retail pesticide prices for the 1991 growing season. A recent study by USDA indicates that basic pesticide manufacturing costs might increase 1 percent with $30.00-per- barrel oil and 3 percent if it rose to $40.00.

Average farm-level herbicide prices rose 4.7 percent between 1989 and 1990, less than the 5.5 percent experienced a year earlier. Atrazine, a major corn and grain sorghum herbicide, showed the greatest increase—8.5 percent. This came on the heels of an 18.4 percent increase in 1989. At $2.93 per pound a.i., the atrazine price is the highest farmers have paid since 1976 when it stood at $3.40. Between 1968 and 1975, atrazine prices ranged between $2.80 and $3.70 per pound.

Farm-level insecticide prices are projected to be up 2.2 percent, compared with 1.0 percent last year. The price of methyl parathion (used extensively in cotton production for boll weevil control) was down 24 percent in 1990, following an increase of 31 percent a year earlier. Spring 1989 trappings indicated the possibility of heavy boll weevil pressure. Growers therefore stocked up on methyl parathion, tightening supplies and increasing the price. The manufacturers responded with higher production and when the boll weevil threat did not materialize, inventory carryover into the 1990 season resulted in a drop in methyl parathion prices.

Table 25--Projected pesticide use on major U.S. field crops, 1990

Crops	June 1 planted acres	Herbicides	Insecticides	Fungicides
	Million	Million pounds (a.i.)		
Row:				
Corn	74.6	222	27.4	0.06
Cotton	12.4	19	18.4	0.19
Grain sorghum	10.7	10	1.7	0.00
Peanuts	1.7	6	1.4	6.32
Soybeans	58.0	102	9.0	0.06
Tobacco	0.7	1	2.8	0.37
Total	158.1	360	60.7	7.00
Small grains:				
Barley and oats	18.7	5	0.1	0.00
Rice	2.9	12	0.5	0.07
Wheat	77.3	16	2.2	0.89
Total	98.9	33	2.8	0.96
1990 total	257.0	393	63.5	7.96
1989 total	259.9	394	61.0	7.77

Table 26--April farm pesticide prices 1/

Pesticides	1988	1989	1990	Change 89-90
	Dollars per pound 2/			Percent
Herbicides:				
Alachlor	5.10	5.40	5.70	5.6
Atrazine	2.28	2.70	2.93	8.5
Butylate	3.10	3.10	3.13	1.0
Cyanazine	4.78	5.03	5.43	8.0
Metolachlor	6.21	6.61	6.94	5.0
Trifluralin	6.45	6.60	6.70	1.5
2,4-D	2.53	2.60	2.71	4.2
Composite 3/	4.20	4.43	4.64	4.7
Insecticides:				
Carbaryl	4.06	4.07	4.36	7.1
Carbofuran	9.36	9.51	9.77	2.7
Chlorpyrifos	8.50	9.05	9.65	6.6
Fonofos	8.83	8.96	9.26	3.3
Methyl parathion 4/	2.94	3.85	2.94	-23.6
Phorate	6.68	6.85	7.25	5.8
Pyrethroids 5/	48.08	48.08 6/	50.00	4.0
Terbufos	9.88	10.13	10.52	3.8
Composite 3/	10.57	10.67	10.91	2.2

1/ Derived from the April survey of farm supply dealers conducted by the NASS, USDA. 2/ Active ingredients. 3/ Includes above materials and other major materials but not products registered in the last 2 to 3 years. 4/ Supplied by Fred Cooke, Mississippi Agricultural Experiment Station. 5/ Average of fenvalerate and permethrin prices based on 2.6 pounds active ingredient per gallon. 6/ Revised.

Pesticide Use on Rice

In 1989, herbicides were used on 97 percent, insecticides on 22 percent, and fungicides on 22 percent of the rice acreage in the surveyed States—Arkansas, California, and Louisiana (table 27). No foliar fungicides were reported for California, because none are registered for that State's common disease problems of stem rot and sheath spot.

About one-third of the rice acreage received one herbicide treatment and 44 percent two treatments. Insecticides and fungicides were generally used only once (table 28).

Propanil was the most commonly used herbicide in rice production, either alone or in combination with other materials

Table 27--Rice acres treated with pesticides, 1989 1/

Category, State	1000 acres planted	1000 acres treated	Percent treated
Herbicides:			
Arkansas	1150	1120	97
California	415	412	99
Louisiana	520	499	96
Area	2085	2031	97
Insecticides:			
Arkansas	1150	15	1
California	415	279	67
Louisiana	520	157	30
Area	2085	451	22
Fungicides:			
Arkansas	1150	316	27
California	415	nr	
Louisiana	520	149	29
Area	2085	465	22

1/ States planted 75 percent of U.S. acreage.
nr = None reported.

to broaden the weed control spectrum (table 29). Molinate ranked second in importance. Both are used primarily to control barnyardgrass and a variety of other grass and broadleaf weeds. Bensulfuron-methyl, first registered for the 1989 growing season, was used extensively in California to control broadleaf weeds and sedges in rice production.

Carbofuran was used in all three States to control the rice water weevil. Methyl parathion is used to control rice stink bugs and grasshoppers; in California, it also is used to control tadpole shrimp. Tadpole shrimp control plays a vital role in California rice production because a large proportion of the acreage is water-seeded. As the rice seed germinates, the shrimp cut off the sprout. Later, as they burrow into the soil to lay eggs, they damage the roots of the rice seedling. Although listed as a herbicide because it controls algae, copper sulfate is used extensively in California, primarily for shrimp.

Sheath blight, caused by a soil-borne organism, poses the gravest disease problem in rice production. It kills the foliage, thereby reducing yields. Benomyl and propiconazol are only partially effective"they can slow development of sheath blight, not control it.

Pesticide Use on Fall Potatoes

Fall potatoes are grown across the northern United States, from Maine to Washington. Herbicides were applied to 83 percent of the fall potato acreage in the 11 surveyed States (table 30). However, in Minnesota and North Dakota, where rainfall is low, only 40 to 50 percent of the acreage was treated with herbicides. Insecticide use was fairly uniform across all States. The proportion of acreage treated with fungicides was highest in the humid eastern States and lowest in the more arid western States.

Table 28--Rice acres treated with pesticides by number of treatments, 1989 1/

Category, State	Number of treatments 1	2	>3	Average acre-treatments
	----Percent----			Number
Herbicides:				
Arkansas	35	48	3	1.87
California	11	47	5	2.38
Louisiana	50	35	1	1.66
Area	34	44	3	1.92
Insecticides:				
Arkansas	100			1.00
California	72	27		1.29
Louisiana	[illegible]	12		1.18
Area	77	21		1.24
Fungicides:				
Arkansas	86	14		1.14
Louisiana	74	26		1.26
Area	82	18		1.18

1/ See Table 27 for acres treated.
nr = None reported.

Herbicides were applied once on 77 percent of the fall potato acreage, and twice on 20 percent (table 31). Insecticide acre-treatments averaged 2.1, ranging from about 1.2 in Colorado and Idaho to 3.6 in Pennsylvania (table 32). Fungicide acre-treatments were highest in Maine at 8.8, followed by Wisconsin at 6.2 (table 33). In the Pacific Northwest and Colorado, average fungicide acre-treatments ranged from 1.3 to 1.5.

Table 29--Selected pesticides used in rice production, 1989

Item	AR	CA	LA	Area
1000 acres treated with herbicides	1120	412	499	2031
Treated acres by active ingredient:		Percent		
Single materials--				
Aciflurofen	4	nr	1	3
Bensulfuron-methyl	nr	87	9	20
Bentazon	1	1	8	3
Copper sulfate	nr	40	nr	[illegible]
Fenoxaprop-ethyl	5	nr	1	3
MCPA	nr	15	nr	3
Molinate	21	79	31	35
Propanil	88	1	37	58
Thiobencarb	7	12	4	7
2,4-D	19	[illegible]	27	17
Other	[illegible]	1	[illegible]	3
Combinations--				
Aciflurofen + bentazon	1	nr	[illegible]	2
Propanil + bentazon	[illegible]	nr	6	2
Propanil + molinate	10	nr	26	12
Propanil + pendimethalin	10	nr	1	6
Propanil + thiobencarb	9	nr	5	6
Other	[illegible]	3	[illegible]	5
Average acre-treatments	1.87	2.38	1.66	1.92
1000 acres treated with insecticides	15	279	157	451
Treated acres by active ingredient:		Percent		
Single materials--				
Carbofuran	33	86	87	85
Methyl parathion	33	41	26	35
Other	34	[illegible]	6	5
Average acre-treatments	1.00	1.29	1.18	1.24
1000 acres treated with fungicides	316	nr	149	465
Treated acres by active ingredient:		Percent		
Single materials--				
Benomyl	63	nr	51	59
Propiconazol	47	nr	74	55
Other	5	nr	nr	3
Average acre-treatments	1.14	nr	1.26	1.18

nr = None reported. * = Less than 1 percent.

Table 30--Pesticide use on fall potatoes, 1989 1/

State	Acres planted	Acres treated with Herbicides	Insecticides	Fungicides
	1,000	--------Percent--------		
Colorado	62	70	63	[illegible]
Idaho	355	93	84	38
Maine	81	99	100	99
Michigan	30	93	100	94
Minnesota	67	52	100	[illegible]
New York 2/	23	97	90	94
North Dakota	125	42	99	86
Oregon	52	[illegible]	92	73
Pennsylvania	21	[illegible]	96	94
Washington	118	94	95	72
Wisconsin	70	95	100	98
Area	1004	[illegible]	91	69

1/ These States planted 92 percent of the fall potato acreage. 2/ Excludes Long Island.

Herbicides

Metribuzin was the most commonly used herbicide in fall potato production (table 34). It was either used alone or tank-mixed with other herbicides to broaden the weed control spectrum. Metribuzin requires moisture shortly after treatment to be effective. A large share of the fall potatoes in the Pacific Northwest are treated with metribuzin because most of the crop is irrigated. Metribuzin is generally applied after planting but before the potatoes emerge. It controls such weeds as foxtail, ragweed, pigweed, and mustard.

EPTC was the second most commonly used herbicide. It is a selective herbicide that can be applied preplant or after planting prior to weed germination. It controls pigweed, foxtails, and wild oats. EPTC must be incorporated into the soil because it is readily lost by volatization. It is most effective where rainfall is low, and is therefore more often used in arid areas.

Table 31--Fall potato acres treated with herbicides by number of treatments, 1989

State	Number of treatments				Average acre-treatments
	1	2	3	>3	
	Percent				Number
Colorado	93	7	nr	nr	1.07
Idaho	75	24	1	nr	1.24
Maine	93	7	nr	nr	1.07
Michigan	68	29	3	nr	1.36
Minnesota	[illegible]	18	nr	2	1.23
New York 1/	70	20	10	nr	1.40
North Dakota	92	6	2	nr	1.10
Oregon	43	42	14	1	1.74
Pennsylvania	71	23	5	1	1.36
Washington	79	12	10	nr	1.31
Wisconsin	68	30	1	1	1.35
Area	77	20	3	*	1.27

nr = None reported. * = Less than 1 percent.

1/ Excludes Long Island.

Table 32--Fall potato acres treated with insecticides by number of treatments, 1989

State	Number of treatments						Average acre-treatments
	1	2	3	4	5	>5	
	Percent						Number
Colorado	90	5	5	nr	nr	nr	1.15
Idaho	75	21	3	nr	nr	nr	1.28
Maine	21	29	23	18	4	6	2.84
Michigan	30	20	22	[illegible]	9	11	2.85
Minnesota	[illegible]	33	41	4	14	nr	2.83
New York 1/	14	21	32	7	14	11	3.18
North Dakota	10	31	47	6	6	nr	2.69
Oregon	45	37	11	3	3	nr	1.82
Pennsylvania	11	24	21	12	18	13	3.60
Washington	37	45	9	7	2	nr	1.93
Wisconsin	28	41	13	5	6	[illegible]	2.59
Area	43	29	17	5	4	2	2.08

nr = None reported.

1/ Excludes Long Island.

Insecticides

Colorado potato beetles, aphids, and leafhoppers constitute the major insect problems in potato production. The Colorado potato beetle has developed some resistance to a number of organophosphorus insecticides, and to some of the newer synthetic pyrethroids.

The most commonly used insecticides across all States are esfenvalerate, methamidophos, permethrin, and phorate (table 35). Aldicarb use is restricted in some areas of Maine and Wisconsin, and prohibited in Suffolk County, Long Island, New York because of groundwater considerations. Carbofuran and phosphamidon are used extensively in Minnesota and North Dakota. Carbofuran, a systemic, is generally applied at planting for flea beetle and early season Colorado potato beetle control. Phosphamidon, an organophosphate, is still effective against the Colorado potato beetle in these two States and is inexpensive to use.

Fungicides

Mancozeb and maneb-zinc are the two most commonly used fungicides in fall potato production (table 36). Early and late blight are the two most serious diseases.

Table 33--Fall potato acres treated with fungicides by number of treatments, 1989

State	Number of treatments											Average acre-treatments
	1	2	3	4	5	6	7	8	9	10	>10	
	Percent											Number
Colorado	79	14	2	5	nr	nr	nr	nr	nr	nr	nr	1.34
Idaho	66	30	4	nr	nr	nr	nr	nr	nr	nr	nr	1.38
Maine	2	nr	1	7	3	7	[illegible]	13	11	30	18	8.75
Michigan	25	11	16	5	19	[illegible]	10	2	3	nr	nr	3.75
Minnesota	35	15	24	15	1	3	nr	4	nr	2	2	2.98
New York 1/	10	34	24	24	3	3	nr	nr	nr	nr	nr	2.86
North Dakota	52	19	18	12	nr	nr	nr	nr	nr	nr	nr	1.90
Oregon	60	30	7	1	1	nr	nr	nr	nr	nr	nr	1.53
Pennsylvania	19	18	14	9	11	4	[illegible]	[illegible]	5	6	nr	4.29
Washington	78	14	3	5	nr	nr	nr	nr	nr	nr	nr	1.35
Wisconsin	13	7	7	[illegible]	11	6	6	11	5	12	13	6.25
Area	46	17	9	7	3	2	2	3	2	5	4	3.17

nr = None reported.

1/ Excludes Long Island.

Early blight kills the potato vine, reducing the food supply available for tuber production in the hill. Late blight kills the vine, and can also infect developed tubers, making them vulnerable to decay in storage. In a potato hill with several vines, the blight organism may infect only some of them.

The disease organism is harbored in volunteer potato plants and in decaying vines and tubers left in the field from previous years. The disease organism can contaminate the potato plant when rain splashes infected soil particles onto the foliage.

Both mancozeb and maneb-zinc are protective fungicides"they must kill the disease organism before it invades the foliage. This explains the large number of fungicide treatments in high rainfall areas.

Regulatory Issues

Current pesticide regulatory concerns are focused on food safety, water quality, and avian mortality. Fungicides used on fruits and vegetable constitute a major food safety concern. In December 1989, the Environmental Protection Agency (EPA) proposed canceling the registrations of

Table 34--Selected herbicides used in fall potato production, 1989

Item	CO	ID	ME	MI	MN	NY 1/	ND	OR	PA	WA	WI	Area
1,000 acres treated with herbicides	44	330	80	28	35	22	52	44	21	111	66	832
Percent of treated acres by active ingredient:												
Single materials--												
EPTC	38	21	1	nr	26	nr	[illegible]	51	12	21	1	14
Glyphosate	nr	*	nr	4	5	13	nr	*	11	nr	12	2
Linuron	2	*	25	31	5	17	nr	nr	7	nr	15	4
Metolachlor	4	1	1	6	5	17	nr	4	nr	1	1	2
Metribuzin	13	65	60	47	8	23	10	35	43	42	55	38
Pendimethalin	nr	2	nr	nr	16	3	17	28	nr	3	3	4
Sethoxydin	nr	2	5	3	13	3	4	1	5	2	[illegible]	3
Trifluralin	nr	1	nr	nr	23	nr	60	nr	nr	7	nr	5
Other	nr	1	7	3	nr	nr	6	13	4	3	nr	2
Combinations mixes--												
Metolachlor + linuron	nr	nr	1	22	nr	20	nr	nr	6	nr	5	1
Metribuzin + EPTC	4	2	nr	1	7	23	nr	1	43	3	20	4
Metribuzin + metolachlor	38	18	nr	1	nr	nr	nr	12	nr	6	nr	8
Metribuzin + pendimethalin	nr	3	nr	nr	[illegible]	3	2	20	2	7	12	4
Trifluralin + EPTC	nr	3	nr	nr	nr	nr	4	2	nr	2	nr	1
Other	7	6	7	17	7	17	nr	7	2	34	3	8
Average acre-treatments	1.07	1.24	1.07	1.36	1.23	1.40	1.10	1.74	1.36	1.31	1.35	1.27

nr = None reported. * = Less than 1 percent.

1/ Excludes Long Island.

Table 35--Selected insecticides used in fall potato production, 1989

Item	CO	ID	ME	MI	MN	NY 1/	ND	OR	PA	WA	WI	Area
1,000 acres treated with insecticides	39	298	81	30	67	21	124	48	20	113	70	911
Percent of treated acres by active ingredient: 2/												
Single materials--												
Aldicarb	nr	3	2	33	nr	nr	nr	20	39	39	nr	9
Axinphos-methyl	nr	*	38	14	nr	14	2	nr	16	1	nr	5
Carbofuran	nr	1	5	13	62	nr	100	3	4	nr	2	20
Disulfoton	8	5	15	3	6	7	nr	5	7	6	23	7
Endosulfan	[illegible]	3	44	33	9	25	17	2	63	nr	13	12
Esfenvalerate	45	4	45	22	34	21	26	2	20	1	40	18
Ethroprop	nr	19	1	nr	nr	nr	nr	8	nr	5	nr	7
Fenvalerate	13	3	nr	nr	31	4	[illegible]	nr	15	4	69	11
Methamidphos	nr	7	60	16	3	46	nr	54	27	52	18	21
Permethrin	15	9	36	6	4	43	3	26	24	2	48	14
Phorate	nr	52	1	24	25	11	32	19	24	17	32	30
Phosphamidon	nr	nr	nr	nr	[illegible]	nr	64	nr	nr	nr	nr	15
Other single materials	28	18	6	61	18	86	9	34	33	34	14	22
All combination mixes	nr	6	30	59	3	61	9	[illegible]	88	33	nr	16
Average acre-treatments	1.15	1.28	2.84	2.85	2.83	3.18	2.69	1.82	3.60	1.93	2.59	2.08

nr = None reported. * = Less than 1 percent.

1/ Excludes Long Island. 2/ The data were not tabulated to reveal insecticide-fungicide tank-mixes.

EBDC fungicides (maneb, mancozeb, metiram, and zineb) for use on 45 of 55 fruit and vegetable crops representing 90 percent of current use.

In September 1989, the leading manufacturers voluntarily suspended EBDC registrations for 42 of the 45 crops. EPA is developing its final Position Document on the three remaining uses, tomatoes, potatoes, and bananas.

In January 1989, EPA proposed canceling all granular formulations of carbofuran (a soil insecticide and nematicide), because of their contribution to avian mortality. This pesticide is used mainly on corn, sorghum, rice, and peanuts, but it also is important in the production of some fruit and vegetable crops.

Groundwater contamination is the major issue in EPA's review of the insecticide, aldicarb, and the herbicide, alachlor. Aldicarb is used in cotton, peanut, potato and tobacco production. Alachlor is important in corn and soybean production.

Table 36--Selected fungicides used in fall potato production, 1989

Item	CO	ID	ME	MI	MN	NY 1/	ND	OR	PA	WA	WI	Area
1,000 acres treated with fungicides	54	133	81	28	59	22	108	38	20	85	69	696
Percent of treated acres by active ingredient: 2/												
Single materials--												
Chlorothalonil	59	57	105	2	34	28	2	23	68	10	25	39
Mancozeb	11	19	301	233	88	79	34	24	165	7	314	102
Maneb	nr	[illegible]	30	11	19	3	19	3	16	1	nr	11
Maneb + zinc	4	19	336	54	87	45	87	26	79	14	121	85
Metalaxyl	nr	nr	16	2	nr	3	nr	5	4	6	4	4
Metiram	nr	nr	5	27	nr	nr	nr	nr	nr	13	nr	3
Iprodione	nr	12	nr	nr	nr	nr	nr	28	3	26	nr	7
Triphenyltin hydroxide	7	1	2	4	32	14	19	nr	nr	nr	33	11
Other	11	13	6	15	2	14	4	36	13	47	3	14
Combinations--												
Mancozeb + metalaxyl	nr	nr	20	22	nr	76	nr	1	51	1	11	8
Mancozeb + triphenyltin hydro	nr	nr	nr	nr	nr	nr	nr	nr	nr	nr	77	[illegible]
Maneb + metiram	nr	nr	nr	nr	30	nr	25	nr	nr	nr	nr	6
Other	43	9	55	3	5	24	nr	6	31	11	38	19
Average acre-treatments	1.34	1.38	8.75	3.75	2.98	2.86	1.90	1.53	4.29	1.35	6.25	3.17

nr = None reported.

1/ Excludes Long Island. 2/ The data were not tabulated to reveal insecticide-fungicide tank-mixes.

Cotton Pest Management Practices

Walter L. Ferguson

Abstract: Of the 10.2 million acres of upland cotton planted in 1989, insecticides were the most intensively used pesticides in terms of number of applications per acre. Herbicides were second in importance, followed by growth regulators, desiccants or defoliants, and fungicides. The irrigated West, Delta, and Southeast cotton accounted for the highest percentages of chemically treated and professionally scouted acres. Cultivation was the most common nonchemical pest management practice, followed by stalk destruction, disease and insect resistant varieties, and pheromone traps for monitoring insect populations.

Keywords: Cotton, pesticides, scouts, integrated pest management

Relative to most other field crops, cotton production requires intensive and extensive use of chemical pesticides. Using data from the U.S. Department of Agriculture's 1989 cotton surveys, we will examine current pesticide use and other pest management practices used by cotton farmers. Nearly 100 percent of cotton acres were treated with one or more pesticides: herbicides (92 percent), insecticides (73 percent), desiccants or defoliants (54 percent), growth regulators (37 percent), and fungicides (8 percent).

Cotton farmers' use of professional scouts, in terms of acres scouted, increased by 15 percentage points between 1982 and 1989 in the 14 major production States. Scouts assisted farmers in examining alternative strategies for timing pesticide applications and lowering application rates. Objectives of farmers and scouts included avoiding pest resistance, lowering control cost, and increasing the yield and quality of the crop.

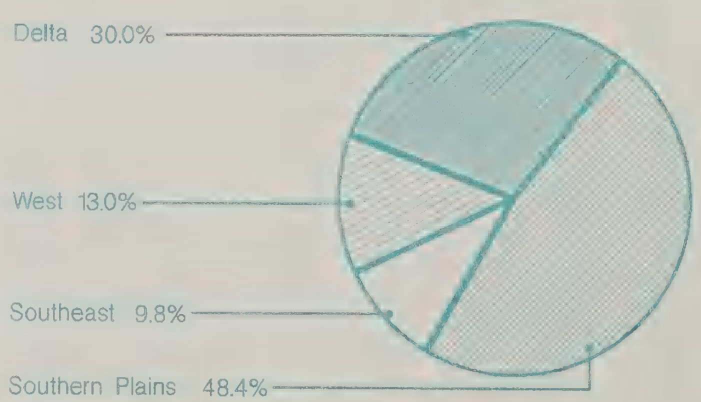
Nearly All Acres Treated With Pesticides

Of the 10.2 million acres of upland cotton planted in the 14 major producing States, 9.9 million acres, or 98 percent, were treated with a pesticide in 1989. The Southern Plains, where about one-half of the cotton acreage is grown, accounted for about 50 percent of the total acres treated with any pesticide, followed by the Delta, West, and Southeast regions (figure A-1). The number of all pesticide applications per treated acre averaged 7.1 for the 14 States (table A-1). Insecticide treatments accounted for the highest number of treatments, followed by herbicides, growth regulators, desiccants or defoliants, and fungicides. Of the 9.9 million total treated acres, 9.4 million were treated with herbicides, 7.4 million with insecticides, 5.4 million with desiccants or defoliants, 3.7 million with growth regulators, and 0.8 million with fungicides (figure A-2) .

Weed control in cotton is complex. Target weed species can be annuals, biennials, or perennials. Severity of infestations varies considerably depending on environmental conditions in different regions. Weeds not only reduce yield by competing for available light, moisture, and nutrients, but also can reduce the quality and marketability of lint. For example, grasses can irreversibly stain the lint during harvest. Nearly 100 percent of the planted acres in the Southeast and Delta regions were treated with herbicides, in contrast with 82 percent in the West. The drier climate of the two western regions allows less intensive use of herbicides. Only one application was used on about 65 percent and 50 percent of the crop in the Southern Plains and West as compared with about 10 percent in the Southeast and Delta (table A-1). In addition, farmers use cultivation to control weeds in the row middles. For the 14 States, farmers cultivated an average of 3.7 times with little variation across regions (table A-2).

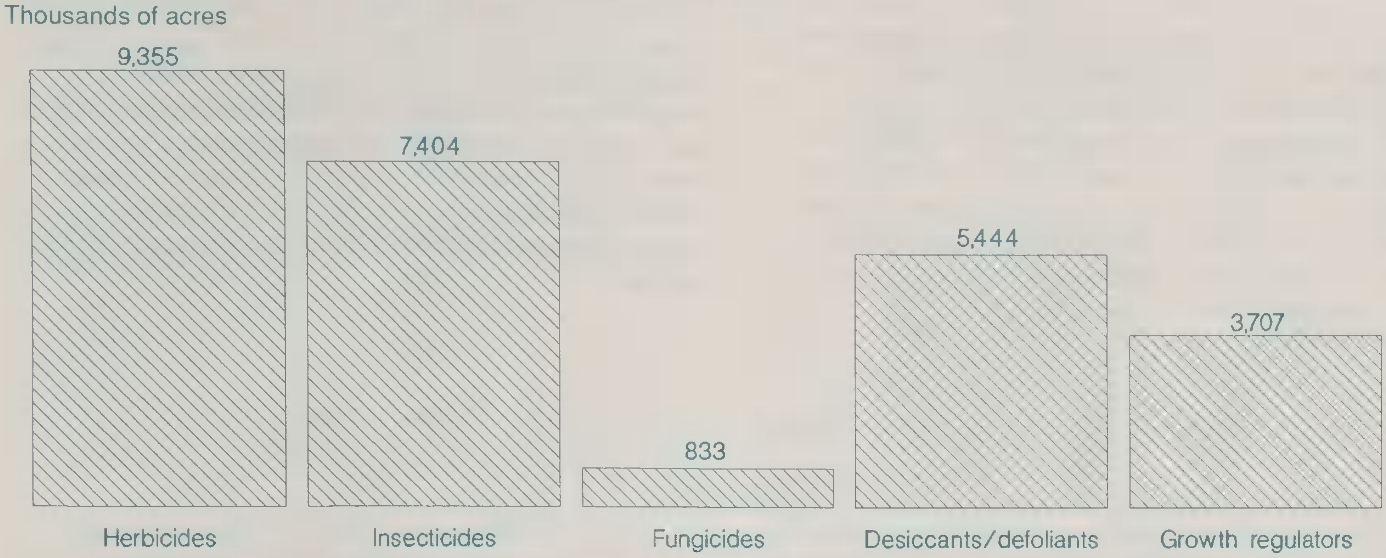
Major insect pests affecting cotton production include the boll weevil *(Anthonomus grandus)*, pink bollworm *(Pectinophora gossypiella)*, bollworm *(Helicoverpa zea)*, and tobacco budworm *(Heliothis virescens)*. As a major pest, the boll weevil range is from the Atlantic coast to the Imperial Valley of California. The pink bollworm range includes Texas, Oklahoma, New Mexico, Arizona, and the Im-

Figure A-1
Cotton Acres Treated by Any Pesticide, 1989



Southeast: AL, GA, NC, SC
Delta: AR, LA, MO, MS, TN
Southern Plains: OK, TX, NM
West: AZ, CA

Figure A-2
Cotton Acres Treated by Type of Pesticide, 1989[1]



1/ States covered: AL, AR, AZ, CA, GA, LA, MO, MS, NC, NM, OK, SC, TN, TX.

perial Valley of California. The bollworm and the tobacco budworm are problems throughout the Cotton Belt.

Surveyed cotton producers in the 14 States reported using insecticides in 1989 to treat 73 percent of the total planted acres. Five or more insecticide treatments were used on 32 percent of the crop acres. About 17 percent received one treatment. The proportion of planted acres treated by insecticides ranged from 98 and 92 percent in the Southeast and Delta regions, respectively, to 57 percent in the Southern Plains. The number of insecticide treatments averaged 5.4 per acre for the 14 States, ranging from 10.8 treatments in the Southeast to 2.5 in the Southern Plains. About 70 percent of the Southeast and Delta acreage was treated using five treatments or more.

About 6 percent of the 1989 planted cotton acreage was included in the boll weevil eradication program, a program funded jointly by cotton farmers and Federal and State governments to remove boll weevil populations from a designated area. The program includes some or all of the following: insecticide-treated-trap crop plantings, pheromone traps, diapause control, and use of sterile males. The boll weevil eradication program on 40 percent of the Southeast acreage helped to increase on the number of treatments per acre in that region. The eradication program has been completed in Virginia, North Carolina, and South Carolina. The area is now in a monitoring and maintainence phase. The eradication program is currently operational in Georgia, Florida and south Alabama. When completed, the number of applications will likely decrease, resulting in lower control cost and higher yield. For example, the boll weevil eradication programs in North Carolina and South Carolina resulted in an estimated increase in returns of about $78 per acre in 1986 (1). The increase was attributed to pesticide cost saving, yield increase, and land value growth as a result of the improved yield.

As a standard practice, cotton growers plant with fungicide-treated seed to reduce the incidence of seed rot and seedling disease. In fields with a history of stand loss due to soil-borne seedling diseases, growers might apply a fungicide in the seed furrow during planting. Such fungicide applications were made on 0.8 million acres or 8 percent of the total planted acres (table A-1). The Delta and Southeast regions accounted for the highest proportion of planted acreage treated with 21 and 15 percent, respectively. In addition, some cotton growers plant disease resistant varieties or use crop rotations to lessen the impact of diseases.

Desiccants and defoliants are used to remove or reduce the cotton plant leaves to facilitate harvest by mechanical pickers or strippers. Growth regulators are used to control vegetative growth to establish more uniform plants, compress the fruiting and harvesting periods, and avoid late-season pest damage to foliage (2). Desiccants or defoliants and growth regulators were used on 54 and 37 percent, respectively, of the total planted acres. One treatment of a desiccant or defoliant was applied on 35 percent of the crop acres and two treatments on 16 percent. The West region accounted for the highest proportion of acreage treated with 96 percent, and the Southern Plains the least with 23 percent. One treatment of growth regulators was used on 24 percent of the crop acres and two treatments on 6 percent. The Delta region accounted for the highest proportion of acreage treated with 65 percent, followed by the West and Southeast regions, each with about 50 percent. A 14-State average of 1.8 growth regulator treatments was used with a range of 2.2 treatments in the Delta to 1.3 treatments in the Southern Plains and West regions.

Integrated Pest Management Practices

Many farmers realize that reliance solely on chemical control can have indirect adverse effects on pest control cost and associated yield. Examples include increased incidence of pest resistance to insecticides, destruction of beneficial insects, and replacement of one major weed by another. Pest management practices are directed toward manipulating the environment to: (a) reduce sources of pest food and shelter, (b) lower the rate of pest population increase and damage, and (c) concentrate pests in small areas for direct control with minimum disruption to beneficial species.

A professional scout is defined as an employee under the supervision of a private consulting firm or the Extension Service. The scout's responsibilities are to visit the cotton field, report the presence and population levels of various insects, and recommend specific control measures to the farmer. Recommendations include specific chemical, cultural, and biological control measures. In order to minimize the use of pesticides, one objective of scouting is to apply chemical controls at the economic threshold level. This is generally defined as the level at which the benefits of control exceed the cost.

Table A-1--Pesticide use, cotton: Acres treated and number of treatments, 1989 1/ 2/

Item	14 States	Southeast	Delta	Southern Plains	West
			1,000		
Acres planted	10,157	852	2,974	5,041	1,290
		Percent of acres treated			
Any pesticide	98	100	100	95	100
Herbicides	92	98	99	89	82
Insecticides	73	98	92	57	74
Fungicides	8	15	21	1	2
Desiccants/defoliants	54	74	80	23	96
Growth regulators	37	49	65	14	52
		Number of treatments per treated acre			
Any pesticide	7.1	14.9	11.6	3.3	6.2
Herbicides	2.1	2.9	3.3	1.4	1.4
Insecticides	5.4	10.8	7.3	2.5	4.1
Fungicides	1.0	1.0	1.0	1.0	1.7
Desiccants/defoliants	1.4	1.1	1.3	1.4	1.7
Growth regulators	1.8	1.7	2.2	1.3	1.3
		Percent of acres planted			
Herbicides:					
One treatment	41	10	7	64	52
Two treatments	24	36	24	22	25
Three treatments	12	23	29	3	4
Four treatments	8	19	20	1	0
Five or more treatments	7	9	20	0	1
Insecticides:					
One treatment	17	1	4	27	18
Two treatments	7	8	3	7	12
Three treatments	11	5	10	11	17
Four treatments	6	10	6	6	4
Five or more treatments	32	73	68	6	22
Fungicides:					
One treatment	8	15	21	1	1
Two treatments	0	0	0	0	0
Three treatments	0	0	0	0	0
Four treatments	0	0	0	0	0
Five or more treatments	0	0	0	0	0
Desiccants/defoliants:					
One treatment	35	64	60	15	39
Two treatments	16	10	18	8	50
Three treatments	1	0	2	0	6
Four treatments	0	0	1	0	1
Five or more treatments	0	0	0	0	0
Growth regulators:					
One treatment	24	31	36	11	40
Two treatments	6	9	11	1	11
Three treatments	2	1	5	1	1
Four treatments	3	0	6	0	0
Five or more treatments	2	0	7	0	0

1/ Regions defined: Southeast (AL, GA, NC, SC); Delta (AR, LA, MO, MS, TN); Southern Plains (OK, TX, NM); and West (AZ, CA). 2/ Preliminary data.

Table A-2--Cotton pest management practices, 1989 1/ 2/

Pest management	Units	14 States	Southeast	Delta	Southern Plains	West
Acres planted	1,000	10,157	852	2,974	5,041	1,290
Acres in scouting program	Percent	56	57	70	44	73
Scouting trips per acre	Number	18	17	22	12	25
Proportion of acres planted that had:						
Resistant varieties	Percent	40	74	38	29	70
Pheromone traps	Percent	34	78	39	9	90
Diapause control--						
Stalk destruction	Percent	74	96	85	58	98
Insecticide treatment	Percent	21	64	25	10	26
Acres cultivated	Percent	97	98	97	98	92
Cultivations per acre	Number	3.7	3.3	3.5	3.7	4.2
Acres in boll weevil eradication program	Percent	6	40	0	0	17

1/ Regions defined in table A-1. 2/ Preliminary data.

According to surveyed cotton farmers, 56 percent of the cotton acreage in the 14 major producing States was scouted by professional scouts in 1989 as compared with 41 percent in 1982 (3). In 1989, an estimated 70 percent of the planted acreage in the Delta and West regions was in a scouting program as compared with 44 percent in the Southern Plains (table A-2). The number of scouting trips during the 1989 season averaged about 18 per acre for the 14 States, ranging from 25 in the West region to 12 in the Southern Plains.

The benefits for ground water quality and the environment will likely be further enhanced as farmers increasingly adopt nonchemical strategies to avoid pest resistance to the pesticides in current use. Although not examined in the survey, early maturing cotton varieties also are used as part of some pest management programs.

Plant breeders have developed cotton varieties that have some resistance to various pathogens and nematodes. A few varieties provide low levels of resistance to specific insects, for example plant bugs. Surveyed farmers in the 14 States reported use of resistant varieties on 40 percent of the total acres, ranging from 74 percent in the Southeast to 29 percent in the Southern Plains.

Pheromone traps refers to the use of sexual attractants to monitor insect populations. For example, a primary use of pheromone traps in boll weevil control is to determine when the population level is high enough to warrant an insecticide application. In 1989, pheromone traps were used on 34 percent of the total planted acres, ranging from 90 percent in the West to only 9 percent in the Southern Plains.

Diapause is defined as a period of insect dormancy or inactivity. Diapause control efforts focus on reducing late season insect populations, food sources, and overwintering sites. Unlike the boll weevil, which diapauses as an adult, the pink bollworm diapauses as a larva, thus it cannot fly and is more vulnerable to control. Diapause control practices are based on the pink bollworms' propensity to overwinter in the crop residue left in the field after harvest. Practices include harvesting early, shredding stalks, and plowing under the stalk remnants immediately. Arizona and California have State plow-down laws requiring that the cotton plant be disposed of to eliminate a food source for bollworms and boll weevils. In 1989, the practice of stalk destruction was used on 74 percent of the 10.2 million cotton acres. Stalk destruction practices ranged from over 95 percent of the planted acreage in the West and Southeast regions to 58 percent in the Southern Plains.

Boll weevil diapause control refers to similar practices plus late season insecticide applications that help reduce the insect populations prior to the period of dormancy or inactivity. Surveyed farmers reported use of insect treatments on 21 percent of the crop acres, ranging from 64 percent in the Delta region to only 10 percent in the Southern Plains.

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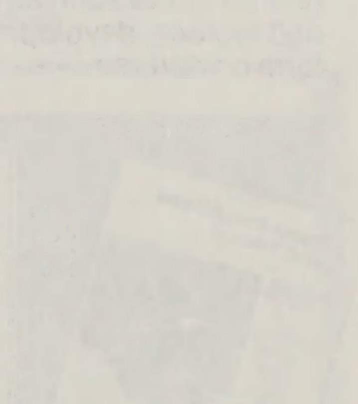

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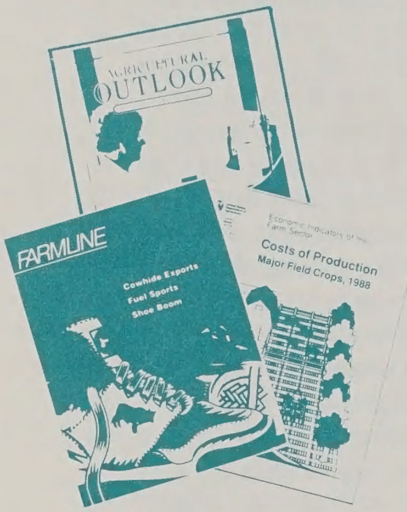

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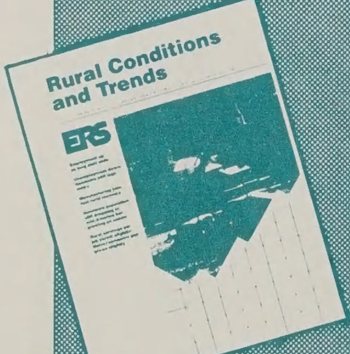

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